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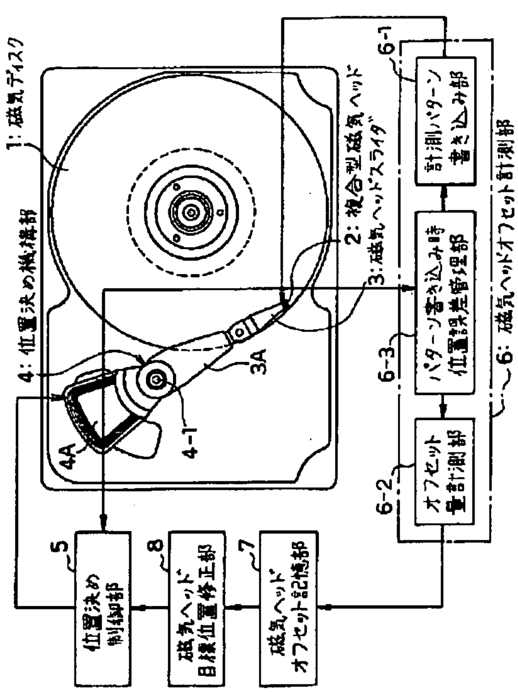
(54)【発明の名称】　磁気ディスク装置

(57)【要約】
【課題】　再生時に再生ヘッドを高精度にオントラックさせて、連続データの転送速度の速い複合型磁気ヘッドを用いた磁気ディスク装置を提供する。
【解決手段】　磁気ヘッドオフセット計測部６において、複合型磁気ヘッド２の磁気ディスク１の半径方向における再生ヘッドの位置と記録ヘッドの位置の差のヘッドオフセット量を高精度に計測する。計測したヘッドオフセット量を磁気ヘッドオフセット記憶部７に記憶しておき、再生時に、磁気ヘッド目標位置修正部８により前記ヘッドオフセット量に基づいて位置決め制御部５を制御して目標位置を修正する。これにより、再生ヘッドを目標トラック上に記録された情報データに高精度で追従させる。



【特許請求の範囲】

【請求項１】　磁気ディスクにデータを記録する記録ヘッドおよび記録されたデータを再生する再生ヘッドを有する複合型の磁気ヘッド、

前記複合型の磁気ヘッドを保持する磁気ヘッドスライダ、

前記磁気ヘッドスライダを回動して前記磁気ヘッドを前記磁気ディスクの目標トラックへ位置決めする位置決め機構部、

前記磁気ディスク上に書き込まれ、前記磁気ヘッドによって再生されるサーボ情報に基づいて、目標トラックに対する前記磁気ヘッドの位置の不一致を表す位置誤差信号により前記位置決め機構部の位置決め動作を制御する位置決め制御部、

前記記録ヘッドによって磁気ディスク上にオフセット計測用信号を得るためのサーボパターンを書き込む計測パターン書き込み手段と、前記再生ヘッドを、ヘッド位置決め機構部とヘッド位置決め制御部によって微小移動させながら、再生信号出力が最大となる位置を計測して、前記磁気ヘッド上の前記再生ヘッドと前記記録ヘッドとの位置関係によって生じる、前記磁気デスクの半径方向における前記再生ヘッドの位置と前記記録ヘッドの位置との差の磁気ヘッドオフセット量を計測するオフセット量計測手段と、前記オフセット量計測用信号の書き込み時の位置誤差の大きさによって、再度前記サーボパターンの書き込みを行わせるパターン書き込み時位置誤差管理手段とを有する磁気ヘッドオフセット計測手段、

前記磁気ヘッドオフセット計測手段で計測した前記磁気ヘッドオフセット量を記憶するとともに、前記磁気ヘッドがアクセスしたトラックの位置と計測した前記磁気ヘッドオフセット量との関係を記憶する磁気ヘッドオフセット記憶手段、及び再生時に前記再生ヘッドを、目標トラック上に記録された情報データに追従させるとき、前記磁気ヘッドオフセット記憶手段から読み出した前記磁気ヘッドオフセット量に基づき、磁気ヘッドの位置決め目標位置を修正する補正信号を前記位置決め制御部に出力する磁気ヘッド目標位置修正手段を備えることを特徴とする磁気ディスク装置。

【請求項２】　前記オフセット量計測手段は、

再生信号レベル測定手段、

前記磁気ヘッドを微少距離移動させるヘッド微動手段、

前記ヘッド微動手段により移動して位置決めされた磁気ヘッドの位置毎に測定された複数の再生信号のレベルの平均をとる再生信号平均化手段、

最大の再生信号が得られる磁気ヘッドの位置を検出する再生信号最大値位置検出手段、及び書き込み時の位置誤差の小さい複数のサーボウェッジを、前記再生信号のレベルを測定するサーボウェッジとして選択するサーボウェッジ選択手段を有することを特徴とする請求項１記載の磁気ディスク装置。

【請求項３】　前記再生信号平均化手段は、

前記サーボウェッジ選択手段で選択された複数のサーボウェッジの再生信号のレベルの平均をとる測定ウェッジ平均手段、

少なくとも３回以上の再生信号のレベルの測定値の平均を求める測定値平均手段、

隣接する複数の測定位置における再生信号のレベルの測定値の平均をとる測定位置平均手段、及び前記測定値平均手段の計算において、再生信号のレベルの測定値の最大値と最小値を除く突発性外乱除去手段を有することを特徴とする請求項2記載の磁気ディスク装置。

【請求項４】　前記再生信号最大値位置検出手段は、

再生信号のレベルの測定値が最大値となる磁気ヘッドの位置と、第２番目に大きな値となる磁気ヘッドの位置と、第３番目に大きな値となる磁気ヘッドの位置、あるいは再生信号のレベルの測定値が２つの最大値をとる磁気ヘッドの位置とに基づいて、再生信号のレベルの測定値が最大値をとる磁気ヘッドの位置の検出精度を向上させる測定分解能向上手段を有することを特徴とする請求項2記載の磁気ディスク装置。

【請求項５】　前記再生信号最大値位置検出手段は、

磁気ディスク上の測定位置によって再生信号レベルが飽和するのを防ぐため３つ以上の隣接する測定位置の再生信号の平均をとることを特徴とする請求項４記載の磁気ディスク装置。

【請求項６】　前記磁気ヘッド目標位置修正手段は、

記録ヘッドにより磁気ディスクにオフセット量計測用信号を得るためのサーボパターンを書き込むとき、再生ヘッドを目標トラックの中心へ位置決めすることを特徴とする請求項１記載の磁気ディスク装置。

【請求項７】　前記オフセット量計測手段は、

磁気ディスクの半径の大きさによって区切られた各ゾーンに対する磁気ヘッドオフセット量を近似的に求めるゾーン平均手段を有するとともに、最内周ゾーンと最外周ゾーンとを平均を求める計算から除くリニア近似手段を有することを特徴とする請求項１または２記載の磁気ディスク装置。

【請求項８】　前記パターン書き込み時位置誤差管理手段は、

サーボパターン書き込み時の目標トラックと磁気ヘッドとの位置誤差がトラックピッチの８パーセント以上である場合、再度磁気ディスクにオフセット量計測用信号を得るためのサーボパターンの書き込みを行わせることを特徴とする請求項１記載の磁気ディスク装置。

【請求項９】　前記サーボパターンの書き込み動作あるいは再生動作を磁気ディスクの１回転毎に繰り返すリトライ動作を検出するリトライ検出手段と、リトライ動作の発生頻度に応じて、磁気ヘッドオフセット計測部に再計測を行わせるオフセット再計測手段を有することを特徴とする請求項１記載の磁気ディスク装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、磁気ディスク装置に関し、特に、記録ヘッドと再生ヘッドとを同一の磁気ヘッドスライダ上に設けた磁気ディスク装置に関する。

【従来の技術】

【０００２】近年、マルチメディアの進展に伴って、大容量の映像情報、音声情報、文字情報などを高速で記録再生する高密度の磁気ディスク装置が必要となっている。

【０００３】磁気ディスク装置には、その高密度化に伴い、磁気抵抗効果を応用したMRヘッドあるいはGMRヘッドを再生ヘッドに用い、誘導型ヘッドを記録ヘッドに用いた磁気ヘッドが使用されている。上記の２種類のヘッドは同一の磁気ヘッドスライダ上に装着され、複合型の磁気ヘッドを構成している。

【０００４】磁気ディスク装置のヘッド位置決め機構としては、小型化及び高速化の要求があり、現在の磁気ディスク装置では、慣性の影響を小さくすることができるロータリ型のアクチュエータが用いられている。

【０００５】ロータリ型のアクチュエータを有する磁気ディスク装置では、磁気ヘッドを磁気ディスクのトラックにアクセスするときの磁気ヘッドの軌跡が円弧になる。そのため、磁気ディスクの内周から外周において、磁気ヘッドスライダの中心線と記録トラックの接線とは平行にならずそれぞれトラック毎に異なる角度で交わる。この角度をヨー角という。このヨー角により、再生ヘッドを磁気ディスクのサーボトラックにオントラック（ヘッドがトラック上の正しい位置に位置決めされること）させた場合、記録ヘッドにはオフトラック（ヘッドがトラック上の正しい位置に位置決めされないこと）が生じる。記録ヘッドの中心と再生ヘッドの中心との位置ずれ、厳密には記録ヘッドと再生ヘッドのそれぞれの磁気的中心位置間のずれを「ヘッドオフセット」と呼ぶ。

【０００６】一般の磁気ディスク装置では、記録時は、再生ヘッドであるMRヘッドでサーボトラックに記録されているサーボ信号を検出して、磁気ヘッドを目標位置へ移動し、MRヘッドをサーボトラックにオントラックさせてから、記録ヘッドである誘導型ヘッドでデータを磁気ディスクに書き込む。ヘッドオフセットがあると、MRヘッドをサーボトラックにオントラックさせて、MRヘッドでデータ信号を再生する場合、MRヘッドが、誘導型ヘッドで書き込まれた磁気ディスク上のデータ信号トラック（データトラック）の中心に位置しないことになる。このためデータ信号を正確に再生できない。場合によっては再生動作の繰り返しであるリトライ動作が必要となり、連続データの転送速度に悪影響を与える。

【０００７】またヨー角が大きい場合、MRヘッドをサーボトラックの中心にオントラックさせて誘導型ヘッドで記録し、再生時に、記録されたデータトラックの中心にMRヘッドをオントラックさせようとすると、ヘッドオフセットによりトラック番号、セクタ番号を誤検出するおそれがある。

【０００８】さらに、ヨー角が大きくなると、ヘッドオフセットも大きくなり再生時の実効トラック幅が減少し、再生信号のレベルが低下する。また磁気ヘッド突出面の方向の磁気ディスクの回転方向接線に対するヨー角が発生する。このため、平滑な磁気ディスクの回転によりそのトラックの接線方向に生じる表面付近の空気層流のスライダに対する相対速度が減少する。これにより、浮上している磁気ヘッドスライダの揚力が減少して浮上の高さが低下する。

【０００９】上記諸問題を避けるには、ヨー角は最大１５度から２０度程度に抑えるのが望ましいとされ、内周と外周でほぼ等しくなるように設計されている。

【００１０】このように、複合型の磁気ヘッドでは、MRヘッドの再生ヘッドと、誘導型ヘッドの記録ヘッドの、それぞれの機械的中心と磁気的中心が異なる。そのため特に狭トラックピッチの磁気ディスク装置においては、MRヘッドと誘導型ヘッドのそれぞれの磁気的中心間の距離で表わされるヘッドオフセットが無視できなくなり、性能低下の大きな要因となる。

【００１１】従来のこの種磁気ヘッドを用いた磁気ディスク装置では、このヘッドオフセットに対して以下の各従来例に示すような対策が講じられている。

【００１２】第１の従来例として、特開平３－１６０６７５号公報の、位置ずれ補償方法及び磁気ディスク装置について図１０を参照しつつ説明する。

【００１３】図１０において、外部位置基準センサ３４は、回転アクチュエータ３３を制御するアクチュエータサーボ制御回路３５に位置情報を与え、磁気ヘッド３０の位置を制御する。書き込み回路３７は、記録ヘッド３２に信号を供給して磁気ディスク２９に第１組のサーボ情報を書き込む。次に、読み取りヘッド電子回路３８は再生ヘッド３１で読みとった第１組のサーボ情報信号を処理してアクチュエータサーボ制御回路３５に位置情報を与えて磁気ヘッド３０の位置を制御する。この第１組のサーボ情報信号により制御された位置において、書き込み回路３７は、記録ヘッド３２に信号を供給して磁気ディスク２９に第２組のサーボ情報を書き込む。

【００１４】このように２組のサーボ情報を磁気ディスク２９に書き込むことにより、データトラックの中心とサーボトラックの中心とを一致させず、所定距離だけずらすことができる。この状態で記録ヘッド３２をデータトラックの中心に位置決めすると、再生ヘッド３１は、サーボトラックの中心に位置決めされることになる。すなわち、データを書き込む場合には、再生ヘッド３１を第１組のサーボ情報の書き込み位置に位置決めし、記録ヘッド３２でデータを第２組のサーボ情報トラック上のデータトラック上に書き込む。このようにして書き込ま

れた２組のサーボ情報は、各トラックで、再生ヘッドと記録ヘッドとの間の位置ずれに等しい距離だけ磁気ディスクの半径方向に離れている。

【００１５】次に、第２の従来例として特開平７－３２６０３２号公報の磁気ディスク装置について図１１を参照しつつ説明する。

【００１６】図１１において、磁気ディスク６４に記録されたデータを再生する読取ヘッド６７と、磁気ディスク６４にデータを記録する書込ヘッド６８とが間隔Ｌ２を隔ててキャリッジ６９に装着されているものとする。キャリッジ６９のヘッドの位置決め動作は位置決め制御回路１７により制御される。磁気ディスク６４の最内周のトラック６５および最外周のトラック６６において、書込ヘッド６８がそれぞれトラック６５、６６の中心に位置するとき、読取ヘッド６７の中心と、トラック６５及びトラック６６のそれぞれの中心とのずれ量をＹＩ、ＹＯとする。また、キャリッジ６９と、トラック６５及びトラック６６のそれぞれの接線とがなす角度をθＩ、θＯとする。オフトラック量測定回路１４は、位置決め制御回路１７から受け取る読取ヘッドの出力から上記のずれ量ＹＩ、ＹＯ及び角度θＩ、θＯを測定し、間隔Ｌ＊＊２を算出する。この間隔Ｌ２に基づいてヘッドの位置決めのための補正量Ｙを補正量算出回路１６によりトラック毎に算出する。

【００１７】上記の構成において、位置決め制御回路１７は、オフトラック量測定回路１４からの指令に基づいて、書込ヘッド６８が特定のトラック上にオフセットサーボパターンを形成するように制御する。オフセットサーボパターンとは、書込ヘッド６８が通常書き込むトラックから、外周側と内周側にそれぞれ１／２トラックピッチずつずらして書き込まれた位置決め用のサーボデータである。従って、上記２つのオフセットサーボパターンの中心は、それぞれ書込ヘッド６８の中心である。書込まれたデータ位置をサーボトラックとして扱うので、２つのオフセットサーボパターンの間の中心はデータトラックの中心でもある。読取ヘッド６７が、このオフセットサーボパターンに基づいて位置決めを行うことで、ずれ量ＹＩ、ＹＯ及び角度θＩ、θＯを測定することができる。測定したずれ量ＹＩ、ＹＯ及び角度θＩ、θＯにより、式（１）で読取ヘッド６７と書込ヘッド６８との間隔Ｌ２を算出する。

【００１８】

$$L2 = (YO - YI) / (\tan\theta O - \tan\theta I) \quad (1)$$

【００１９】式（２）でヘッドオフセット量Ｙを算出できる。

【００２０】

$$Y = L2 \cdot \tan\theta \quad (2)$$

【００２１】ここで、キャリッジ６９の位置の関数としてのtanθは、近似が可能である。従ってtanθの値を記憶しておく必要はなく、近似式により算出される値を用いて実際の補正量を算出している。この補正量と補正式を記憶しておき、補正量算出回路１６は、この補正量Ｙを算出して位置決め制御回路１７に出力し、キャリッジ６９の位置決め動作を制御して磁気ヘッドの位置決めを行っている。

【００２２】

【発明が解決しようとする課題】第１の従来例では、トラック毎に補正量を算出していない。また磁気抵抗素子を用いた再生ヘッド特有の機械的中心と磁気的中心とのずれ量は、再生ヘッドの製造時のばらつきにより個々の再生ヘッド毎に異なっているが、この点に対応できる構成をとっていない。そのため狭トラックピッチ（高トラック密度）の磁気ディスク装置においては、リトライ動作の増加、連続データの転送速度の低下などの磁気ディスク装置の性能の低下を避けることができない。また、第２の従来例では、オフセットサーボパターンで位置決めするにあたり、オフセットサーボパターンを書き込む場合の位置のばらつきや、ヘッドオフセット量の測定結果にノイズなどによる誤差が生じる点については言及していない。また、磁気ディスクの最内周と最外周の２つのトラックについてのみヘッドオフセット量である間隔Ｌ２を測定するため、どちらかで誤差を含むと、測定したヘッドオフセット量に大きな誤差が生じる。このため高トラック密度の磁気ディスク装置においては、再生時にリトライ動作が発生し、連続データの転送速度の低下の原因となる。リトライ動作の発生回数を低減し連続データの転送速度を速くするためには、高精度でオフセット量を計測する必要があるという課題を有している。

【００２３】計測用パターン書き込み時の位置のバラツキをなくすために、サーボパターンの一部を使ってオフセット計測を行う方法もある。しかし、計測時にサーボがかけられないという問題を有している。本発明は、複合型の磁気ヘッドの、リトライ動作の発生回数を低減し、連続データの転送速度を高速にできる磁気ディスク装置を提供することを目的とする。

【００２４】

【課題を解決するための手段】本発明の磁気ディスク装置は、磁気ディスクにデータを記録する記録ヘッドおよび記録されたデータを再生する再生ヘッドを有する複合型の磁気ヘッドを備えている。前記複合型の磁気ヘッドは磁気ヘッドスライダに保持され、位置決め機構部により目標のトラックへ位置決めされる。位置決め制御部は前記磁気ディスク上に書き込まれ、前記磁気ヘッドによって再生されるサーボ情報に基づいて、目標トラックと前記磁気ヘッドとの位置の不一致を表す位置誤差信号により前記位置決め機構部の位置決め動作を制御する。

【００２５】さらに磁気ヘッドオフセット計測手段が、前記磁気ヘッド上の、再生ヘッドと記録ヘッドとの位置関係によって生じる、前記磁気ディスクの半径方向にお

ける再生ヘッドの位置と記録ヘッドの位置との差のヘッドオフセット量を計測する。計測した前記ヘッドオフセット量を磁気ヘッドオフセット記憶手段に記録しておく。再生時に再生ヘッドを目標トラック上に記録された情報データに追従させる場合に、前記磁気ヘッドオフセット記憶手段から、読み出したヘッドオフセット量に基づき、磁気ヘッド目標位置修正手段により生成される補正信号を位置決め制御部に送り磁気ヘッドの位置決め目標位置を修正する。

【００２６】この構成によって、複合型磁気ヘッドの記録ヘッドと再生ヘッドの、各トラックにおける磁気ヘッドオフセット量を高精度に計測することが可能となり、再生時に、書き込まれたデータトラックの中心に再生ヘッドであるMRヘッドを正確にオントラックさせることが可能となる。これにより、再生時のデータ再生エラーによるリトライ動作の発生を減少させることが可能であり、連続データ転送速度の低下を防ぐことが可能な磁気ディスク装置を実現することができる。

【００２７】また、前記磁気ヘッドオフセット計測手段は、磁気ディスク上にオフセット計測用信号のサーボパターンを記録ヘッドによって書き込む計測パターン書き込み手段、ヘッド位置決め機構部とヘッド位置決め制御部によって磁気ヘッドを微小移動させながら、再生信号出力が最大である位置を計測してオフセット量を求めるオフセット量計測手段、及び前記計測用信号書き込み時の位置誤差の大きさによって、再度書き込みを行わせるパターン書き込み時位置誤差管理手段を有する。前記オフセット量計測手段は、再生信号出力測定手段、磁気ヘッドを微少距離移動させるヘッド微動手段、前記ヘッド微動手段により移動して位置決めされた磁気ヘッドの位置毎に測定された再生信号のレベルの平均をとる再生信号平均化手段、最大の再生信号が得られる磁気ヘッドの位置を検出する再生出力最大値位置検出手段、及び書き込み時の位置誤差によって、前記再生信号レベルを測定する磁気ディスクのサーボウェッジを選択するサーボウェッジ選択手段を有する。前記再生信号平均化手段は、複数のサーボウェッジの再生信号のレベルの平均をとる測定ウェッジ平均手段、少なくとも３回以上の測定値の平均を求める、測定値平均手段、複数位置の測定値の平均をとる測定位置平均手段、及び測定値平均手段の計算において、最大値と最小値を除く突発性外乱除去手段を有している。

【００２８】この構成の磁気ヘッドオフセット計測手段によって、突発性外乱による誤差の拡大を防止できる。さらに、ヘッド微動手段により微少距離移動させるとともに、複数のサーボウエッジにおいて再生信号レベルを測定し、測定した複数の測定値を平均化して、各トラックにおける磁気ヘッドオフセット量を高精度に計測することが可能となる。これにより、再生時のデータ再生エラーによるリトライ動作の発生を減少させることが可能であり、連続データ転送速度の低下を防ぐことが可能な磁気ディスク装置を実現することができる。

【００２９】

【発明の実施の形態】以下本発明の磁気ディスク装置の好適な実施例について図１から図９を参照しながら説明する。

《実施例１》本発明の実施例１の磁気ディスク装置について、図１から図８を用いて説明する。図１は、本発明の実施例１における磁気ディスク装置の構成を示すブロック図である。図１において、磁気ディスク１の面上で複合型磁気ヘッド２が磁気ヘッドスライダ３によって支持されている。磁気ヘッドスライダ３はアーム３Ａを介して位置決め機構部４に取り付けられている。位置決め機構部４の位置決め動作は位置決め制御部５により制御される。磁気ヘッドオフセット計測部６は計測パターン書き込み部６－１、オフセット量計測部６－２、及びパターン書き込み時位置誤差管理部６－３を備えている。磁気ヘッドオフセット計測部６のパターン書き込み時位置誤差管理部６－３に、磁気ヘッド２の出力が入力される。計測パターン書き込み部６－１の出力は磁気ヘッド２に入力される。磁気ヘッドオフセット計測部６の出力端は磁気ヘッドオフセット記憶部７の入力端に接続され、磁気ヘッドオフセット記録部７の出力端は磁気ヘッド目標位置修正部８の入力端に接続されている。磁気ヘッド目標位置修正部８の出力端は位置決め制御部５の入力端に接続されている。

【００３０】図２は、図１のオフセット量計測部６－２の内部構成を示すブロック図である。オフセット量計測部６－２の入力端に設けられたサーボウェッジ選択部６－２－５の出力端は再生信号レベル測定部６－２－１の入力端に接続されている。再生信号レベル測定部６－２－１の出力端は再生信号平均化部６－２－３の入力端に接続されている。再生信号平均化部６－２－３の出力端は再生信号最大値位置検出部６－２－４の入力端に接続されている。再生信号最大値位置検出部６－２－４の出力端は磁気ヘッドオフセット記録部７の入力端に接続されている。ヘッド微動部６－２－２の出力端は再生信号レベル測定部６－２－１の他の入力端に接続されている。

【００３１】再生信号平均化部６－２－３において、再生信号平均化部６－２－３の入力端に設けられた測定ウェッジ平均部６－２－３－１の出力端は測定値平均部６－２－３－２の入力端に接続されている。測定値平均部６－２－３－２の出力端は、突発性外乱除去部６－２－３－４の入力端に接続されている。突発性外乱除去部６－２－３－４の出力端は測定位置平均部６－２－３－３の入力端とヘッド微動部６－２－２の入力端に接続され、測定位置平均部６－２－３－３の出力端は再生信号最大値位置検出部６－２－４の入力端に接続されている。再生信号最大値位置検出部６－２－４は、測定分解

能向上部６－２－４－１を有している。

【００３２】図３は、磁気ヘッド２の磁気ディスク１に対向する面の平面図であり、本実施例１の磁気ディスク装置おいて、記録再生を行う複合型の磁気ヘッド２が磁気ヘッドスライダ３の端部に設けられている。磁気ヘッド２において、記録ヘッドである薄膜の誘導型ヘッド２－１と、再生ヘッドである磁気抵抗効果型ヘッド（以下、ＭＲヘッドという）２－２が磁気シールド板２－３－２を介して所定距離だけ離れて設けられている。磁気ヘッド２と磁気ヘッドスライダ３との間には、磁気シールド板２－３－１が設けられている。ＭＲヘッド２－２，誘導型ヘッド２－１，シールド板２－３－１及び２－３－２はそれぞれアルミナ２－４の保護層を介して、磁気ヘッドスライダ３に保持されている。磁気ヘッドスライダ３はアーム３Ａを介して位置決め機構部４に取り付けれられている。

【００３３】図４及び図５は位置決め機構部４である揺動型アクチュエータにおけるヨー角について説明するための磁気ディスク装置の平面図である。図４において、磁気ヘッドスライダ３を保持するアーム３Ａはボイスコイルモータ４Ａを有する位置決め機構部４によって、ピボット４－１の回りに回動する。磁気ヘッドスライダ３が磁気ディスク１のデータエリアＡ内の中央にあるとき、ヨー角が零になるように、磁気ディスク１と位置決め機構部４との位置関係が設定されている。図中のトラック１００がヨー角零のトラックである。図５の（ａ）の拡大図に示すように、磁気ヘッド２がトラック１００より内周側のトラック１００－１に位置決めされる場合、アーム３Ａの中心線２３Ａの方向とトラック１００－１の中心線１００－１－Ｃの接線１００－１－Ｔの方向との間に、内周トラックヨー角２００－１が生じる。また、図５の（ｃ）の拡大図に示すように、磁気ヘッド２がトラック１００より外周側のトラック１００－２に位置決めされる場合、スライダアーム３Ａの中心線２３Ａの方向とトラック１００－２の中心線１００－２－Ｃの接線１００－２－Ｔの方向との間に、外周トラックヨー角２００－２が生じる。

【００３４】これらのヨー角２００－１又は２００－２によって、以下に説明するように記録再生時に磁気ヘッド２のオフトラックが発生することとなる。図５の（ｂ）の拡大図に示すように、磁気ヘッド２がトラック１００に位置決めされる場合、中心線１００－Ｃの接線１００－Ｔと、誘導型ヘッド２－１とＭＲヘッド２－２の幾何学的な中心線であるスライダアーム３Ａの中心線２３Ａとが実質的に平行である。従って、記録時、再生時ともＭＲヘッド２－２で後で説明するサーボトラックのサーボパターン信号を検出し、ＭＲヘッド２－２をサーボトラックの中心にオントラックさせることで、正確な記録再生が可能である。誘導型ヘッド２－１とＭＲヘッド２－２のそれぞれの磁気的中心が幾何学的中心と一致していない場合には、その補正が別途必要となる。図５の（ａ）に示すように、トラック１００より内周側のトラック１００－１では、ヨー角２００－１が生じるため、トラック１００－１の中心線１００－１－Ｃの接線１００－１－Ｔが、誘導型ヘッド２－１とＭＲヘッド２－２の幾何学的中心線であるスライダアームの中心線２３Ａと一致しない。このようにヨー角により生じるＭＲヘッド２－２と誘導型ヘッド２－１の幾何学的中心間のずれ量を「オフセット量」と定義する。

【００３５】磁気ディスクに対するデータの記録再生の動作は以下に示すように行なわれる。ＭＲヘッド２－２でサーボトラックのサーボパターン信号を検出する。データの記録時は、ＭＲヘッド２－２をサーボトラックの中心にオントラックさせ、誘導型ヘッド２－１でデータを記録する。データの再生時は、ＭＲヘッド２－２を誘導型ヘッド２－１が書き込んだデータトラックの中心に、オフセット量を考慮して位置決めする。他の方法として、データの記録時は、誘導型ヘッド２－１がデータトラックの中心にオントラックするように、ＭＲヘッド２－２をオフセット量を考慮に入れた位置に位置決めし、データの再生時は、ＭＲヘッド２－２をデータトラックの中心に位置決めする。外周側では、図５の（ｃ）に示すように、ヨー角２００－２が生じるため、トラック１００－２の中心線１００－２－Ｃの接線１００－２－Ｔが、誘導型ヘッド２－１とＭＲヘッド２－２の幾何学的中心線であるスライダアームの中心線２３Ａと一致しない。

【００３６】この場合、ＭＲヘッド２－２でサーボパターン信号を検出する。データの記録時は、ＭＲヘッド２－２をサーボトラックの中心にオントラックさせ、誘導型ヘッド２－１でデータを記録する。データの再生時は、ＭＲヘッド２－２を誘導型ヘッド２－１が書き込んだデータトラックの中心に、オフセット量を考慮して位置決めする。

【００３７】他の方法として、データの記録時は、誘導型ヘッド２－１がトラックの中心にオントラックするように、ＭＲヘッド２－２をオフセット量を考慮に入れた位置に位置決めし、データの再生時は、ＭＲヘッド２－２をデータトラックの中心に位置決めする。このように、磁気ディスクの内周側あるいは外周側において、誘導型ヘッド２－１で書き込んだデータトラックの中心に、ＭＲヘッド２－２をオントラックさせるためには、サーボトラックの中心からオフセット量だけ偏った位置にＭＲヘッド２－２を位置決めすることが必要となる。すなわち、高い精度でヘッド位置決めを行なうためには、高い精度でオフセット量を計測する必要がある。

【００３８】本実施例１の磁気ディスク装置においては、以下の手順でオフセット量の計測を行なう。図６の（ａ）は、磁気ディスク１の平面図である。図において、磁気ディスク１の記録領域は、外周側から内周側に

向かって同心円状のゾーン０からゾーン１６に区切られ、各ゾーンはそれぞれ複数のトラックからなる。各トラックは円周上に区切られた複数の位置情報領域（以下、サーボセクタという）３００とデータ領域２００を有している。図６の（ｂ）は、磁気ディスク１のトラックのサーボセクタ３００に書き込まれた４種類のサーボパターン３００Ａ、３００Ｂ、３００Ｃ、３００Ｄを示す。データはデータデータ領域２００に書き込まれる。図において、磁気ヘッド２－Ａは、磁気ヘッド２が磁気ディスク１の中央部のトラックに位置決めされるときの状態を示し、この場合計測用のサーボパターン３００Ａを検出する。磁気ヘッド２－Ｂは、磁気ヘッド２が磁気ディスク１の外周側のトラックに位置決めされるときの状態を示し、この場合計測用のサーボパターン３００Ｂを検出する。図中の矢印Ｒは磁気ディスク１の回転の方向を示す。

【００３９】以下、オフセット量の計測方法について図１、図２、図５、及び図６を参照して説明する。かっこに入った数字は処理のステップを表わしている。

ステップ（１）：外周側のゾーン０（図６の（ａ））の中央付近の任意のトラックに、再生ヘッドであるＭＲヘッド２－２をオントラックさせて、図１の計測パターン書き込み部６－１によってそのトラックの全サーボセクタに図６の（ｂ）に示すオフトラック量計測用のパターン３００Ｂを書き込む。

【００４０】ステップ（２）：パターン書き込み時位置誤差管理部６－３によって、パターン３００Ｂの書き込み時の各サーボセクタにおける位置誤差を記憶しておく。位置誤差がトラックピッチの８％を越えた場合があれば、再度オフトラック量計測用パターン３００Ｂを書き込む。

【００４１】ステップ（３）：位置誤差がトラックピッチの８％以内であれば、位置誤差の小さかった４つのサーボセクタを、オフセット量計測用のサーボセクタとしてサーボウェッジ選択部６－２－５によって選択する。ただし、計測処理時間の関係で、選択するサーボセクタは１個のトラックの全サーボセクタ数の１／８以下とする。

ステップ（４）：ＭＲヘッド２－２を外周側へハーフトラックピッチＰ／２移動させて位置決めする。

ステップ（５）：１回転当たり、４つのセクタの再生信号レベルを選択し、３回転分の１２セクタの、１２個のデータを一時記憶をする。

【００４２】ステップ（６）：測定ウェッジ平均部６－２－３－１、測定回数平均部６－２－３－２及び突発性外乱除去手段６－２－３－４によって、１２個のデータのうち、最大値を有するものと最小値を有するものを除いた１０個のデータの平均値を求め、その平均値を内部メモリに記憶する。

【００４３】ステップ（７）：磁気ヘッドを、ヘッド微動部６－２－２によって、トラックピッチの１／６４ずつ内周側へ移動して位置決めする。それぞれ移動した位置を測定位置という。測定位置毎にステップ（５）及び（６）の処理を６４回くり返す。図７は、トラック（ｎ）を、その中心線７０に幾何学的中心が一致した状態でトレースするＭＲヘッド２－２の位置と、再生信号レベルＬＶを同じ図に示したものであり、両者の関係を表わしている。図において、誘導型ヘッド２－１の中心線７０からのずれをオフセット量で示している。

【００４４】ステップ（８）：図２の測定位置平均部６－２－３－３によって、測定位置毎に隣接する外周側３個、内周側３個の計７個の測定位置の再生信号レベルを平均する。

【００４５】ステップ（９）：図２の再生信号最大値位置検出部６－２－４によって、図７に示すように、再生信号レベルＬＶが最大となる再生ヘッド２－２の位置である最大値位置の測定点Ｋを検出する。図８は、図７の再生信号レベルＬＶのピーク部の拡大図であり、図８の（ａ）、（ｂ）、及び（ｃ）はそれぞれ、ピーク部の形状の典型的な３つの例を示している。最大値位置の測定点Ｋが１個の場合、ピーク部の形状は図８の（ｂ）又は（ｃ）のようになる。この場合は測定分解能向上部６－２－４－１によって、隣接する３個の位置のデータから、最大値の位置を導出する。また、最大値位置の測定点Ｋが２個以上ある場合、ピーク部の形状は図８の（ａ）のようになり、複数の最大値位置の測定点K_1、K_2をもつ。これらの測定点K_1とK_2に基づいて最大値の位置を導出する。複数の測定点K_1、K_2の間隔は、磁気ヘッドオフセット量に等しい。

【００４６】ステップ（１０）：ステップ（１）から（９）までの処理を各ゾーン０ないし１６で行い、ゾーン毎のオフセット量を導出する。

ステップ（１１）：ゾーン毎のオフセット量のうち、最内周と最外周のゾーン１６、０を除いた１４個のゾーン１、２・・・１５のオフセット量より、各ゾーンにおけるトラック番号とオフセット量との関係を算出し磁気ヘッドオフセット記憶部７に出力し記憶させる。

【００４７】ステップ（１２）：磁気ディスク装置に複数のディスクがある場合、この計測は各ディスクに対応する磁気ヘッドについて行なう。

以上のような計測により、磁気ヘッド２のオフセット量を各トラック毎に磁気ヘッドオフセット記憶部７に記憶しておく。データ再生時に、磁気ヘッド２のそのトラックに対応するオフセット量に相当する距離だけ、磁気ヘッド目標位置修正部８の出力する補正信号で位置決め制御部５により位置決め機構４を動作させる。これにより、ＭＲヘッド２－２をサーボトラックからオフトラックさせて、データトラックの中心にオントラックさせることが可能となる。

【００４８】以上のように、本実施例１の磁気ディスク

装置によれば、磁気ヘッドF2のオフセット量を高精度に計測することにより、磁気ディスク1のすべてのゾーンのデータトラックの中心にMRヘッドF2－2をオントラックさせてデータを再生することが可能となる。

【0049】《実施例2》実施例2における磁気ディスク装置について、図9を用いて説明する。図9は、本発明の実施例2における磁気ディスク装置の構成を示すブロック図である。実施例1と同じ要素には同じ符号を付し、重複する説明を省略する。

【0050】実施例2では、実施例1の構成に加えて、記録あるいは再生動作を磁気ディスクが1回転して同じサーボセクタが到来するのを待ってやり直す、リトライ動作の有無を検出するリトライ検出部9－1と、リトライ動作の発生頻度に応じて、磁気ヘッドF2のオフセット量の再計測を行わせるオフセット再計測部9－2を備えている。位置決め制御部5で制御する位置誤差量が大きく、記録再生時にリトライ動作の発生の頻度が記録再生回数の5パーセント以上になった場合、記録再生を行っていない時間に、オフセット再計測部9－2からの指令信号により再度磁気ヘッドオフセット計測部6に計測動作を行わせる。この場合、各ゾーンとオフセット量との間に近似処理によるリニアな関係があるときは、各ゾーン毎に再計測せずに各ゾーンに対するオフセット量をその関係に基づき変化させてもよい。

【0051】以上のような再計測により求めた磁気ヘッドFのオフセット量の新たな値を記憶しておき、データ再生時に、この記憶した磁気ヘッドF2のオフセット量だけMRヘッドF2－2をサーボトラックからオフトラックさせる。これにより、MRヘッドF2－2をデータトラックの中心にオントラックさせることが可能となる。以上のように、本実施例2の磁気ディスク装置によれば、位置誤差が大きい場合、あるいは、ノイズなどの影響で正しい再生が出来なかった場合でも、磁気ヘッドF2のオフセット量を高精度で計測することが可能となるとともに、高精度なヘッドF位置決めが可能となる。

【0052】

なお、実施例2の磁気ディスク装置において、オフセット再計測部9－2によるオフセット量の再計測を、リトライ動作の発生の頻度が記録再生回数の5パーセント以上の場合に行うとしているが、その他の割合の場合でも同様の効果が得られる。なお、実施例1及び実施例2の磁気ディスク装置では、パターン書き込み時位置誤差管理部6－3による計測用パターンの再書き込みを、位置誤差がトラックピッチの8パーセント以上の場合に行うとしたが、5パーセント以上又は10パーセント以上など他の割合としてもよい。また、オフセット量計測部6－2における再生信号最大値位置検出において、磁気ヘッドF2を外周側へ1／2トラック移動させ、内周側へ1トラック分（内周側1／2トラックの位置まで）の範囲まで測定を行っている。しかし、内周側から外周側へ向かって測定してもよい。また磁気ヘッドF2の初期の位置が1／2トラックだけオフトラックした位置でなくてもよい。また、測定範囲が1トラック分でなくてもよい。

【0053】さらに、再生ヘッドFとしてMRヘッドFを使用しているが、GMRヘッドなど他の再生ヘッドFを組み合わせた複合型の磁気ヘッドFでも同様の効果が得られる。また、磁気ディスクの1回転あたり4つのサーボウェッジを測定用として選択し、選択するサーボセクタは1個のトラックの全サーボセクタの1／8以上としているが、異なる個数を選択しても同様の効果が得られる。

【0054】また、オフセット計測部6－2の測定において、3回転分の12個のデータを取得しているが、異なる回転数で、全データ数が12個以下あるいは以上であっても、同様の効果が得られる。また、突発性外乱除去部6－2－3－4は、最大値、最小値を除去しているが、大きい値を複数個、小さい値を複数個除去しても同様の効果が得られる。

【0055】また、オフセット計測部6－2の測定時の磁気ヘッドFの微少移動をトラックピッチの1／64ずつ移動させているが、これ以外のピッチで移動させても同様の
効果が得られる。また、オフセット計測部6－2において最大値位置検出を行うために、3つ以上の隣接する位置の再生信号の平均を求めたが、スプライン補間などの統計処理を用いても同様の効果が得られる。

【0056】

【発明の効果】以上の各実施例で詳細に説明したところから明らかなように、本発明によれば磁気ディスクの狭トラック化により記録密度を高くする場合においても、高い精度で測定した磁気ヘッドFのオフセット量に基づいて磁気ヘッドFを正確に位置決めできる。その結果、再生時にデータエラーによるリトライ動作が増加し連続データの転送速度が低下することはない。

【図面の簡単な説明】

【図1】本発明の実施例1における磁気ディスク装置のブロック図。

【図2】本発明の実施例1におけるオフセット量計測部のブロック図。

【図3】実施例1における磁気ヘッドFの平面図。

【図4】本発明の実施例1における磁気ディスク装置のヨー角に関する説明のための平面図。

【図5】本発明の実施例1における磁気ディスク装置のヨー角に関する説明のための拡大平面図。

【図6】（a）は本発明の実施例1における磁気ディスクの記録領域を示す平面図、及び（b）は（a）の磁気ディスクのサーボパターン。

【図7】本発明の実施例1における磁気ディスク装置のオフセット計測の説明のための磁気ディスクの平面図。

【図8】（a）ないし（c）は本発明の実施例1における磁気ディスク装置の最大値位置検出のための出力レベ

ルのグラフ。

【図９】本発明の実施例２における磁気ディスク装置のブロック図。

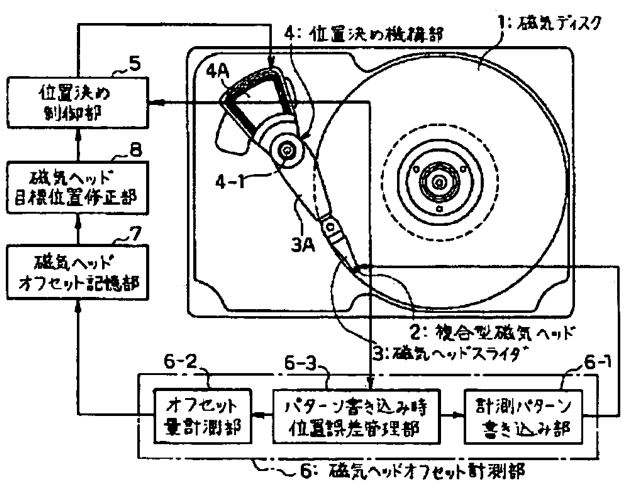
【図１０】第１の従来例の磁気ディスク装置のブロック図。

【図１１】第２の従来例の磁気ディスク装置のブロック図。

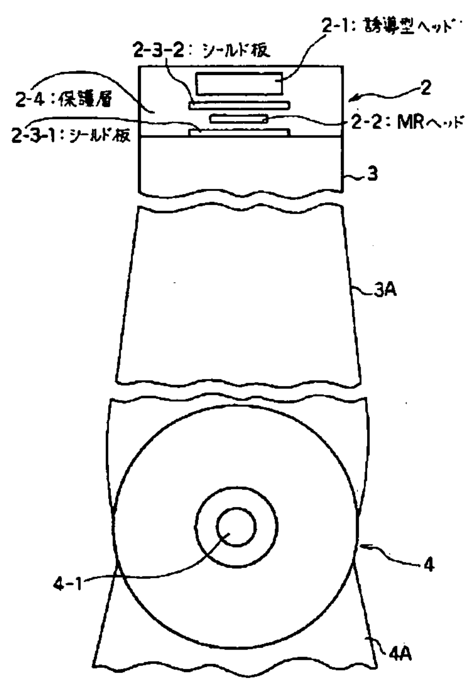
【符号の説明】

1	磁気ディスク
2	複合型磁気ヘッド
3	磁気ヘッドスライダ
3A	アーム
4	位置決め機構部
4A	ボイスコイルモータ
4－1	ピボット
5	位置決め制御部
6	磁気ヘッドオフセット計測部
6－1	計測パターン書き込み部
6－2	オフセット量計測部
6－2－1	再生信号レベル測定部
6－2－2	ヘッド微動部
6－2－3	再生信号平均化部
6－2－3－1	測定ウェッジ平均部
6－2－3－2	測定値平均部
6－2－3－3	測定位置平均部
6－2－3－4	突発性外乱除去部
6－2－4	再生信号最大値位置検出部
6－2－4－1	測定分解能向上部
6－2－5	サーボウェッジ選択部
6－3	パターン書き込み時位置誤差管理部
7	磁気ヘッドオフセット記憶部
8	磁気ヘッド目標位置修正部
9－1	リトライ検出部
9－2	オフセット再計測部
23A	幾何学的中心線
100	トラック
100－1	トラック
100－2	トラック
200	データ領域
200－1	ヨー角
200－2	ヨー角
300	位置情報領域

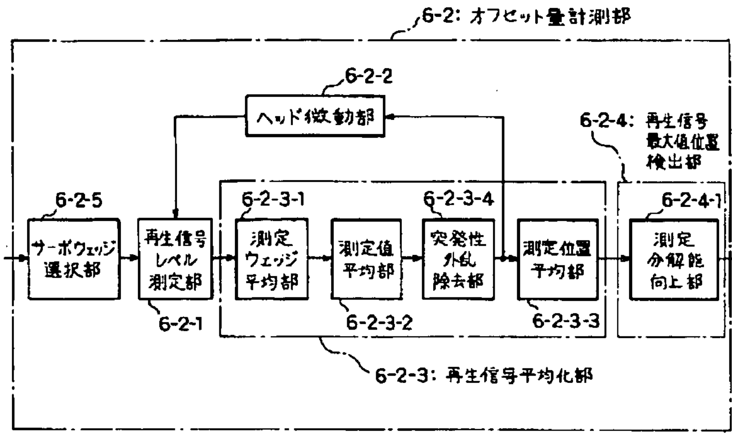
【図１】



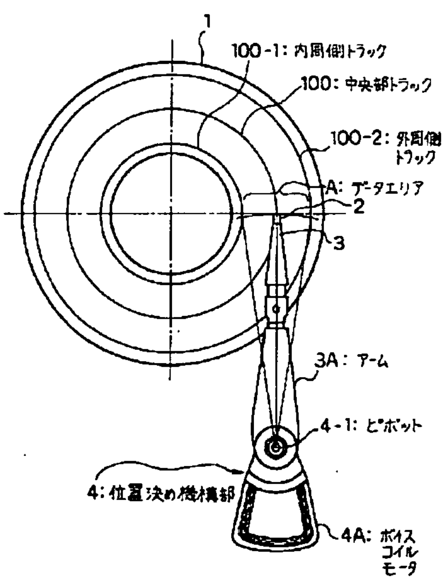
【図３】



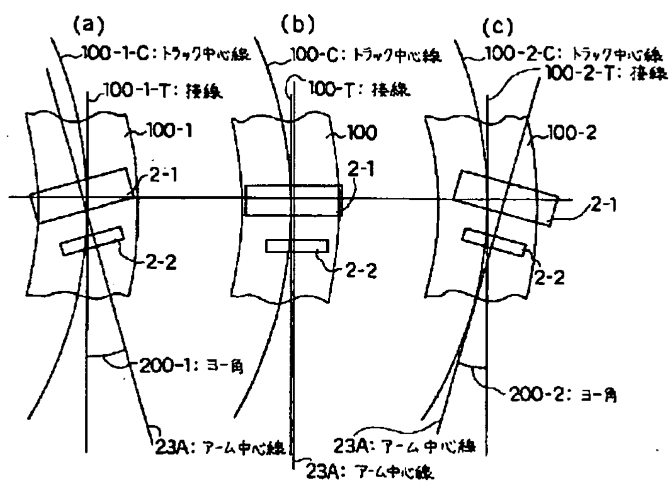
【図２】


6-2: オフセット量計測部
6-2-2
ヘッド微動部
6-2-4: 再生信号最大値位置検出部
6-2-5
サーボウェッジ選択部
再生信号レベル測定部
6-2-3-1
測定ウェッジ平均部
測定値平均部
6-2-3-4
突発性外乱除去部
測定位置平均部
6-2-4-1
測定分解能向上部
6-2-1
6-2-3-2
6-2-3-3
6-2-3: 再生信号平均化部

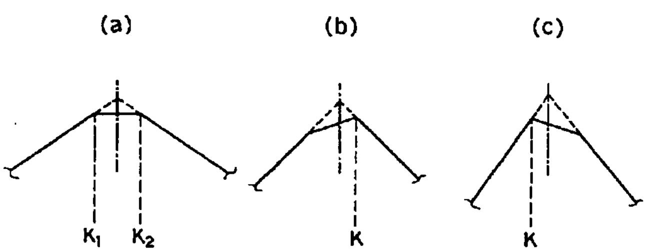
【図４】


1
100-1: 内周側トラック
100: 中央部トラック
100-2: 外周側トラック
A: データエリア
2
3
3A: アーム
4-1: ピボット
4: 位置決め機構部
4A: ボイスコイルモータ

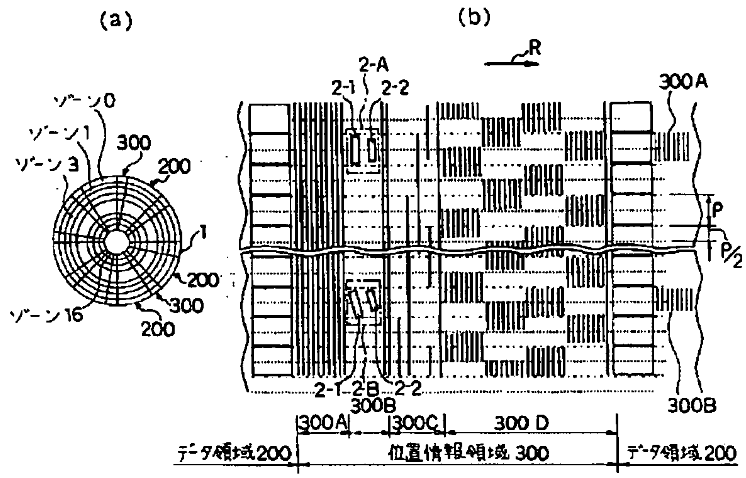
【図５】


(a)
(b)
(c)
100-1-C: トラック中心線
100-1-T: 接線
100-1
2-1
2-2
200-1: ヨー角
23A: アーム中心線
100-C: トラック中心線
100-T: 接線
100
2-1
2-2
23A: アーム中心線
100-2-C: トラック中心線
100-2-T: 接線
100-2
2-1
2-2
200-2: ヨー角
23A: アーム中心線

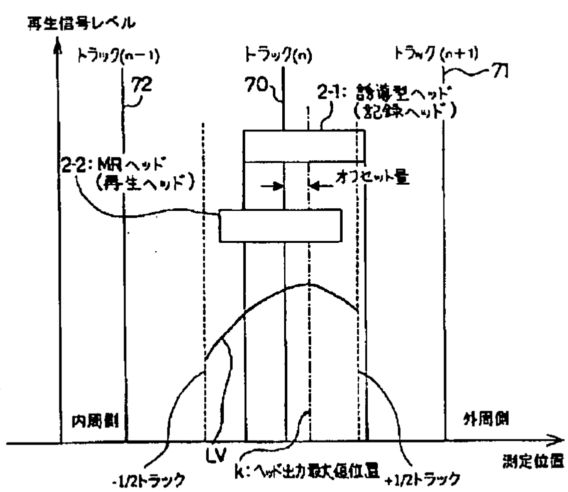
【図８】


(a)
(b)
(c)
K1
K2
K
K

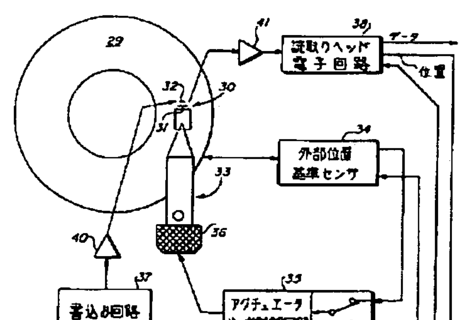
【図６】


(a)
(b)
ゾーン0
ゾーン1
ゾーン3
ゾーン16
300
200
1
R
2-A
2-1
2-2
2B
300A
300B
300C
300 D
P
P/2
データ領域200
位置情報領域 300
データ領域200

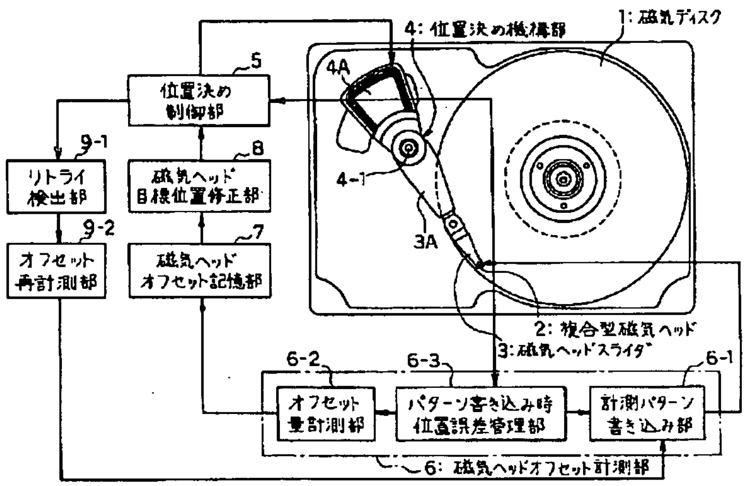
【図７】


再生信号レベル
トラック(n−1)
トラック(n)
トラック(n+1)
72
70
71
2-1: 誘導型ヘッド (記録ヘッド)
2-2: MRヘッド (再生ヘッド)
オフセット量
内周側
外周側
LV
-1/2トラック
k: ヘッド出力最大値位置
+1/2トラック
測定位置

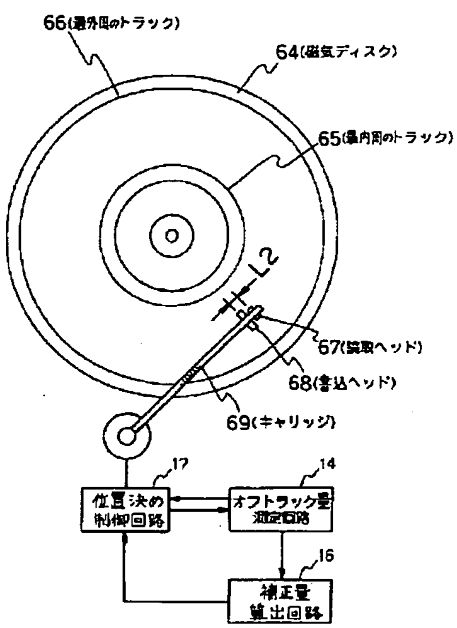
【図１０】


29
41
38
データ
読取りヘッド電子回路
位置
32
30
31
33
34
外部位置基準センサ
36
40
37
書込み回路
35
アクチュエータサーボ制御回路
39
タイミングおよび制御電子回路

【図９】



【図１１】



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CLAIMS

[Claim(s)]
[Claim 1] The magnetic head of the compound die which has the reproducing head which reproduces the recording head which records data on a magnetic disk, and the recorded data, The positioning device section which rotates the magnetic-head slider holding the magnetic head of said compound die, and said magnetic-head slider, and positions said magnetic head to the target truck of said magnetic disk, It is written in on said magnetic disk and based on the servo information reproduced by said magnetic head. The point-to-point control section which controls positioning actuation of said positioning device section by the position error signal showing the inequality of the location of said magnetic head to a target truck, The measurement pattern write-in means which writes in the servo pattern for acquiring the signal for offset measurement on a magnetic disk by said recording head, Said reproducing head, carrying out minute migration by the head positioning device section and the head point-to-point control section Measure the location where a regenerative-signal output serves as max, and are generated according to the physical relationship of said reproducing head and said recording head on said magnetic head. An amount measurement means of offset to measure the amount of magnetic head offsets of the difference of the location of said reproducing head which can set said magnetic disk radially, and the location of said recording head, With the magnitude of the position error at the time of the writing of said signal for the amount measurement of offset A magnetic head offset measurement means to have a position error management tool at the time of the pattern writing in which said servo pattern is made to write again, While memorizing said amount of magnetic head offsets measured with said magnetic head offset measurement means A magnetic head offset storage means to memorize the relation between the location of the truck which said magnetic head accessed, and said measured amount of magnetic head offsets, And when making said reproducing head follow the information data recorded on the target truck at the time of playback, The magnetic disk drive characterized by having a magnetic-head target-position correction means to output the amendment signal which corrects the positioning target position of the magnetic head to said positioning control section, based on said amount of magnetic head offsets read from said magnetic head offset storage means.
[Claim 2] A head jogging means by which said amount measurement means of offset carries out very small distance migration of a regenerative-signal level measurement means and said magnetic head, A regenerative-signal equalization means to take the average of the level of two or more regenerative signals measured for every location of the magnetic head which moved with said head jogging means and was positioned, A regenerative-signal maximum location detection means to detect the location of the magnetic head where the greatest regenerative signal is acquired, And the magnetic disk drive according to claim 1 characterized by having a servo wedge selection means to choose two or more servo wedges with the small position error at the time of writing as a servo wedge which measures the level of said regenerative signal.
[Claim 3] A measurement wedge average means to take the average of the level of the regenerative signal of two or more servo wedges as which said regenerative-signal equalization means was chosen with said servo wedge selection means, In count of a measured-value average means to ask for the average of the measured value of the level of at least 3 times or more of regenerative signals, a measuring-point average means to take the average of the measured value of the level of the regenerative signal in two or more adjoining measuring points, and said measured-value average means The magnetic disk drive according to claim 2 characterized by having a burst nature disturbance clearance means except the maximum and the minimum value of measured value of a regenerative signal. [of level]
[Claim 4] The location of the magnetic head where, as for said regenerative-signal maximum location detection means, the measured value of the level of a regenerative signal turns into maximum, The location of the magnetic head which serves as a big value the 2nd, and the location of the magnetic head which serves as a big value the 3rd, Or the magnetic disk drive according to claim 2 with which measured value of the level of a regenerative signal is characterized by having the improvement means in resolution of measurement which raises the detection

precision of the location of the magnetic head which takes maximum based on the location of the magnetic head which takes the maximum whose measured value of the level of a regenerative signal is two.
[Claim 5] Said regenerative-signal maximum location detection means is a magnetic disk drive according to claim 4 characterized by taking the average of the regenerative signal of three or more adjoining measuring points in order to prevent saturating regenerative-signal level by the measuring point on a magnetic disk.
[Claim 6] Said magnetic-head target-position correction means is a magnetic disk drive according to claim 1 characterized by positioning the reproducing head to the core of a target truck when writing in the servo pattern for acquiring the signal for the amount measurement of offset to a magnetic disk by the recording head.
[Claim 7] Said amount measurement means of offset is a magnetic disk drive according to claim 1 or 2 characterized by having the linear approximation means which removes the most inner zone and an outermost periphery zone from the count which asks for an average while having a zone average means to calculate in approximation the amount of magnetic head offsets to each zone divided by the magnitude of the radius of a magnetic disk.
[Claim 8] A position error management tool is a magnetic disk drive according to claim 1 again characterized by making the servo pattern for acquiring the signal for the amount measurement of offset to a magnetic disk write in when the position error of the target truck at the time of servo pattern writing and the magnetic head is 8% or more of a track pitch at the time of said pattern writing.
[Claim 9] The magnetic disk drive according to claim 1 characterized by having a retry detection means to detect the retry actuation which repeats write-in actuation or playback actuation of said servo pattern for every revolution of a magnetic disk, and an offset re-measurement means to make re-measurement perform in the magnetic head offset measurement section according to the occurrence frequency of retry actuation.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to the magnetic disk drive which prepared a recording head and the reproducing head on the same magnetic-head slider about a magnetic disk drive.
[Description of the Prior Art]
[0002] In recent years, the magnetic disk drive of the high density which carries out record playback of mass image information, speech information, the text, etc. at high speed is needed with progress of multimedia.
[0003] The magnetic head which used the MR head or GMR head adapting a magneto-resistive effect for the reproducing head in connection with the densification, and used the induction type head for the recording head is used for the magnetic disk drive. It is equipped with two kinds of above-mentioned heads on the same magnetic-head slider, and they constitute the magnetic head of a compound die.
[0004] As a head positioning device of a magnetic disk drive, there is a demand of a miniaturization and improvement in the speed, and the actuator of the rotary mold which can make effect of inertia small is used with the present magnetic disk drive.
[0005] In the magnetic disk drive which has the actuator of a rotary mold, the locus of the magnetic head when accessing the magnetic head on the truck of a magnetic disk becomes radii. Therefore, it crosses at an include angle which the center line of a magnetic-head slider and the tangent of a recording track are not parallel, but is different for every truck in a periphery, respectively from the inner circumference of a magnetic disk. This include angle is called yaw angle. When the servo track of a magnetic disk is made to carry out the on-truck (for a head to be positioned in the right location on a truck) of the reproducing head according to this yaw angle, in a recording head, an off-track (a head should not be positioned in the right location on a truck) arises. the location gap with the core of a recording head, and the core of the reproducing head -- the gap between each magnetic hit alignment location of a recording head and the reproducing head is strictly called a "head offset."
[0006] With a common magnetic disk drive, at the time of record, after detecting the servo signal currently recorded on the servo track by the MR head which is the reproducing head, moving the magnetic head to a target position and making a servo track carry out the on-truck of the MR head, data are written in a magnetic disk with the induction type head which is a recording head. An MR head will be located at the core of the data signal truck on the magnetic disk written in with the induction type head (data tracks), when making a servo track carry out the on-truck of the MR head and reproducing a data signal by the MR head, if there is a head offset. For this reason, a

data signal is unreproducible to accuracy. By the case, the retry actuation which is the repeat of playback actuation is needed, and it has an adverse effect on a continuation data transfer rate.
[0007] Moreover, when a yaw angle is large, and the core of a servo track tends to be made to carry out the on-truck of the MR head and it is going to make the core of the data tracks which recorded with the induction type head and were recorded at the time of playback carry out the on-truck of the MR head, there is a possibility that a head offset may incorrect-detect a track number and a sector number.
[0008] Furthermore, if a yaw angle becomes large, a head offset will also become large, the effective width of recording track at the time of playback will decrease, and the level of a regenerative signal will fall. Moreover, the yaw angle over the hand-of-cut tangent of the magnetic disk of the direction of a magnetic-head projection side occurs. For this reason, the relative velocity to the slider of the air laminar flow near [which is produced in the tangential direction of that truck by revolution of a smooth magnetic disk] a front face decreases. The lift of the magnetic-head slider which has surfaced decreases by this, and the height of floatation falls.
[0009] In order to avoid many above-mentioned problems, a yaw angle is made desirable [holding down from a maximum of 15 degrees to about 20 degrees], and it is designed so that it may become almost equal on inner circumference and a periphery.
[0010] Thus, in the magnetic head of a compound die, each machine hit alignment and the magnetic hit alignment of the reproducing head of an MR head and the recording head of an induction type head differ from each other. Therefore, especially in the magnetic disk drive of a narrow track pitch, it becomes impossible to disregard the head offset expressed with the distance between each magnetic hit alignment of an MR head and an induction type head, and becomes the big factor of degradation.
[0011] in the magnetic disk drive using this conventional seed magnetic head, the cure as shown in the example since each ** of the following to this head offset is taken.
[0012] It explains as 1st conventional example, referring to drawing 10 about the location gap compensation approach and magnetic disk drive of JP,3-160675,A.
[0013] In drawing 10 , the external datum reference sensor 34 gives positional information to the actuator servo control circuit 35 which controls the revolution actuator 33, and controls the location of the magnetic head 30. The write-in circuit 37 supplies a signal to a recording head 32, and writes the servo information on the 1st set in a magnetic disk 29. Next, the reading head electronic circuitry 38 processes the servo information signal of the 1st set read by the reproducing head 31, gives positional information to the actuator servo control circuit 35, and controls the location of the magnetic head 30. In the location controlled by this servo information signal of the 1st set, the write-in circuit 37 supplies a signal to a recording head 32, and writes the servo information on the 2nd set in a magnetic disk 29.
[0014] Thus, by writing 2 sets of servo information in a magnetic disk 29, the core of data tracks and the core of a servo track are not made in agreement, but only predetermined distance can be shifted. When a recording head 32 is positioned at the core of data tracks in this condition, the reproducing head 31 will be positioned at the core of a servo track. That is, in writing in data, the reproducing head 31 is positioned in the write-in location of the servo information on the 1st set, and it writes in data on the data tracks on the servo code track of the 2nd set by the recording head 32. Thus, 2 sets of written-in servo information is each truck, and it is separated from it of a distance equal to the location gap between the reproducing head and a recording head to radial [of a magnetic disk].
[0015] Next, it explains, referring to drawing 11 about the magnetic disk drive of JP,7-326032,A as 2nd conventional example.
[0016] In drawing 11 , the read head 67 which reproduces the data recorded on the magnetic disk 64, and the write head 68 which records data on a magnetic disk 64 shall separate spacing L2, and carriage 69 shall be equipped with it. Positioning actuation of the head of carriage 69 is controlled by the point-to-point control circuit 17. In the truck 65 of the most inner circumference of a magnetic disk 64, and the truck 66 of the outermost periphery, when the write head 68 is located at the core of trucks 65 and 66, respectively, the amount of gaps of the core of a read head 67 and each core of a truck 65 and a truck 66 is set to YI and YO. Moreover, the include angle which carriage 69 and each tangent of a truck 65 and a truck 66 make is set to thetaI and thetaO. The amount measuring circuit 14 of off-tracks measures the above-mentioned amounts YI and YO of gaps and include-angle thetaI, and thetaO from the output of the read head received from the point-to-point control circuit 17, and computes spacing L2. Based on this spacing L2, the amount Y of amendments for positioning of a head is computed for every truck by the amount calculation circuit 16 of amendments.
[0017] In the above-mentioned configuration, based on the command from the amount measuring circuit 14 of off-tracks, the point-to-point control circuit 17 is controlled so that the write head 68 forms an offset servo pattern on a specific truck. An offset servo pattern is servo data for positioning with which the write head 68 shifted 1/2

track pitch at a time, and was written in the periphery and inner circumference side from the usually written-in truck, respectively. Therefore, the core of the two above-mentioned offset servo patterns is a core of the write head 68, respectively. Since the written-in data location is treated as a servo track, the core between two offset servo patterns is also a core of data tracks. A read head 67 can measure the amounts YI and YO of gaps and include-angle thetaI, and thetaO by positioning based on this offset servo pattern. The spacing L2 of a read head 67 and the write head 68 is computed by the formula (1) by the measured amounts YI and YO of gaps and include-angle thetaI, and thetaO.
[0018]
L2=(YO-YI) / (tanthetaO-tanthetaI) (1)
[0019] The amount Y of head offsets is computable by the formula (2).
[0020]
Y=L2andtantheta (2)
[0021] Here, tantheta as a function of the location of carriage 69 can be approximated. Therefore, it is not necessary to memorize the value of tantheta and the actual amount of amendments is computed using the value computed by the approximation. Memorizing this amount of amendments and correction formula, the amount calculation circuit 16 of amendments computes this amount Y of amendments, outputs it to the point-to-point-control circuit 17, controls positioning actuation of carriage 69, and is positioning the magnetic head.
[0022]
[Problem(s) to be Solved by the Invention] In the 1st conventional example, the amount of amendments is not computed for every truck. Moreover, although the amount of gaps of the machine hit alignment peculiar to the reproducing head and the magnetic hit alignment using a magnetic resistance element changes for each reproducing head of every with dispersion at the time of manufacture of the reproducing head, it has not taken the configuration which can respond to this point. Therefore, in the magnetic disk drive of a narrow track pitch (high track density), the performance degradation of magnetic disk drives, such as an increment in retry actuation and lowering of a continuation data transfer rate, is unavoidable. Moreover, in positioning by the offset servo pattern, in the 2nd conventional example, reference is not made about the point which the error by a noise etc. produces in dispersion in the location in the case of writing in an offset servo pattern, and the measurement result of the amount of head offsets. Moreover, if an error is included by either in order to measure the spacing L2 which is the amount of head offsets only about two trucks, the most inner circumference of a magnetic disk, and the outermost periphery, gross errors will arise in the measured amount of head offsets. For this reason, in the magnetic disk drive of high track density, retry actuation occurs at the time of playback, and it becomes the cause of lowering of a continuation data transfer rate. In order to reduce the count of generating of retry actuation and to make a continuation data transfer rate quick, it has the technical problem that it is highly precise and it necessary to measure the amount of offset.
[0023] In order to abolish the variation in the location at the time of the pattern writing for measurement, there is also a method of performing offset measurement using some servo patterns. However, it has the problem that a servo is not applied at the time of measurement. This invention reduces the count of generating of retry actuation of the magnetic head of a compound die, and aims at offering the magnetic disk drive as for which a continuation data transfer rate is made to a high speed.
[0024]
[Means for Solving the Problem] The magnetic disk drive of this invention is equipped with the magnetic head of the compound die which has the reproducing head which reproduces the recording head which records data on a magnetic disk, and the recorded data. The magnetic head of said compound die is held at a magnetic-head slider, and is positioned by the positioning device section to a target truck. The point-to-point-control section is written in on said magnetic disk, and controls positioning actuation of said positioning device section by the position error signal showing the inequality of the location of a target truck and said magnetic head based on the servo information reproduced by said magnetic head.
[0025] Furthermore, a magnetic head offset measurement means measures the amount of head offsets of the difference of the location of the reproducing head and the location of a recording head which are produced according to the physical relationship of the reproducing head and the recording head on said magnetic head and which can set said magnetic disk radially. Said measured amount of head offsets is recorded on the magnetic head offset storage means. The positioning target position of the delivery magnetic head is corrected to the point-to-point control section for the amendment signal generated by the magnetic-head target-position correction means based on the amount of head offsets which read it from said magnetic head offset storage means when making the reproducing head follow the information data recorded on the target truck at the time of playback.
[0026] It becomes possible to measure the amount of magnetic head offsets in each truck of the recording head

and the reproducing head of the compound-die magnetic head to high degree of accuracy by this configuration, and it becomes possible to make the core of the data tracks written in at the time of playback carry out the on-truck of the MR head which is the reproducing head to accuracy. Thereby, it is realizable the magnetic disk drive [it is possible to decrease generating of the retry actuation by the data playback error at the time of playback, and] which can prevent lowering of a continuation data transfer rate.
[0027] Moreover, said magnetic head offset measurement means has a position error management tool at the time of the pattern writing in which it makes write again with the magnitude of an amount measurement means of offset measure the location whose regenerative-signal output is max, and calculate the amount of offset, and the position error at the time of said signal writing for measurement, carrying out the minute migration of the magnetic head by the measurement pattern write-in means and the head positioning device section which write in the servo pattern of the signal for offset measurement by the recording head on a magnetic disk, and the head point-to-point-control section. A head jogging means by which said amount measurement means of offset carries out very small distance migration of a regenerative-signal output measurement means and the magnetic head, A regenerative-signal equalization means to take the average of the level of the regenerative signal measured for every location of the magnetic head which moved with said head jogging means and was positioned, It has a servo wedge selection means to choose the servo wedge of the magnetic disk which measures said regenerative-signal level according to a playback output maximum location detection means to detect the location of the magnetic head where the greatest regenerative signal is acquired, and the position error at the time of writing. Said regenerative-signal equalization means has the burst nature disturbance clearance means except maximum and the minimum value in count of a measured-value average means to ask for the average of a measurement wedge average means to take the average of the level of the regenerative signal of two or more servo wedges, and at least 3 times or more of measured value, a measuring-point average means to take the average of the measured value of two or more locations, and a measured-value average means.
[0028] With the magnetic head offset measurement means of this configuration, amplification of the error by burst nature disturbance can be prevented. Furthermore, while carrying out very small distance migration with a head jogging means, two or more measured value which measured and measured regenerative-signal level in two or more servo wedges is equalized, and it becomes possible to measure the amount of magnetic head offsets in each truck to high degree of accuracy. Thereby, it is realizable the magnetic disk drive [it is possible to decrease generating of the retry actuation by the data playback error at the time of playback, and] which can prevent lowering of a continuation data transfer rate.
[0029]
[Embodiment of the Invention] It explains referring to drawing 9 from drawing 1 about the suitable example of the magnetic disk drive of this invention below.
<<example 1>> The magnetic disk drive of the example 1 of this invention is explained using drawing 8 from drawing 1 . Drawing 1 is the block diagram showing the configuration of the magnetic disk drive in the example 1 of this invention. In drawing 1 , the compound-die magnetic head 2 is supported by the magnetic-head slider 3 on the field of a magnetic disk 1. The magnetic-head slider 3 is attached in the positioning device section 4 through arm 3A. Positioning actuation of the positioning device section 4 is controlled by the point-to-point control section 5. The magnetic head offset measurement section 6 is equipped with the position error Management Department 6-3 at the time of the measurement pattern write-in section 6-1, the amount measurement section 6-2 of offset, and pattern writing. The output of the magnetic head 2 is inputted into the position error Management Department 6-3 at the time of the pattern writing of the magnetic head offset measurement section 6. The output of the measurement pattern write-in section 6-1 is inputted into the magnetic head 2. The outgoing end of the magnetic head offset measurement section 6 is connected to the input edge of the magnetic head offset storage section 7, and the outgoing end of the magnetic head offset Records Department 7 is connected to the input edge of the magnetic-head target-position correction section 8. The outgoing end of the magnetic-head target-position correction section 8 is connected to the input edge of the point-to-point control section 5.
[0030] Drawing 2 is the block diagram showing the internal configuration of the amount measurement section 6-2 of offset of drawing 1 . The outgoing end of the servo wedge selection section 6-2-5 prepared in the input edge of the amount measurement section 6-2 of offset is connected to the input edge of the regenerative-signal level test section 6-2-1. The outgoing end of the regenerative-signal level test section 6-2-1 is connected to the input edge of the regenerative-signal equalization section 6-2-3. The outgoing end of the regenerative-signal equalization section 6-2-3 is connected to the input edge of the regenerative-signal maximum location detecting element 6-2-4. The outgoing end of the regenerative-signal maximum location detecting element 6-2-4 is connected to the input edge of the magnetic head offset Records Department 7. The outgoing end of the head jogging section 6-2-2 is connected to other input edges of the regenerative-signal level test section 6-2-1.

[0031] In the regenerative-signal equalization section 6-2-3, the outgoing end of the measurement wedge average section 6-2-3-1 prepared in the input edge of the regenerative-signal equalization section 6-2-3 is connected to the input edge of the measured-value average section 6-2-3-2. The outgoing end of the measured-value average section 6-2-3-2 is connected to the input edge of the burst nature disturbance clearance section 6-2-3-4. The outgoing end of the burst nature disturbance clearance section 6-2-3-4 is connected to the input edge of the measuring-point average section 6-2-3-3, and the input edge of the head jogging section 6-2-2, and the outgoing end of the measuring-point average section 6-2-3-3 is connected to the input edge of the regenerative-signal maximum location detecting element 6-2-4. The regenerative-signal maximum location detecting element 6-2-4 has the improvement section 6-2-4-1 in resolution of measurement.
[0032] the top view of the field where drawing 3 counters the magnetic disk 1 of the magnetic head 2 -- it is -- the magnetic disk drive of this example 1 -- it is and the magnetic head 2 of the compound die which performs record playback is formed in the edge of the magnetic-head slider 3. In the magnetic head 2, through the magnetic-shielding plate 2-3-2, only predetermined distance separates and the induction type head 2-1 of the thin film which is a recording head, and the magneto-resistive effect mold head (henceforth an MR head) 2-2 which is the reproducing head are formed. Between the magnetic head 2 and the magnetic-head slider 3, the magnetic-shielding plate 2-3-1 is formed. MR head 2-2, the induction type head 2-1, the shielding plate 2-3-1, and 2-3-2 are held through the protective layer of an alumina 2-4 at the magnetic-head slider 3, respectively. It attaches in the positioning device section 4 through arm 3A, and the magnetic-head slider 3 is ************.
[0033] Drawing 4 and drawing 5 are the top views of the magnetic disk drive for explaining the yaw angle in the oscillating motor which is the positioning device section 4. In drawing 4 , arm 3A holding the magnetic-head slider 3 rotates around the pivot 4-1 by the positioning device section 4 which has voice coil motor 4A. When there is a magnetic-head slider 3 in the center in the data area A of a magnetic disk 1, the physical relationship of a magnetic disk 1 and the positioning device section 4 is set up so that a yaw angle may become zero. The truck 100 in drawing is a truck of yaw angle zero. As shown in the enlarged drawing of (a) of drawing 5 , when the magnetic head 2 is positioned from a truck 100 on the truck 100-1 by the side of inner circumference, the inner circumference truck yaw angle 200-1 arises between the direction of center line 23A of arm 3A, and the direction of tangent 100-1-T of center line 100-1-C of a truck 100-1. Moreover, as shown in the enlarged drawing of (c) of drawing 5 , when the magnetic head 2 is positioned on the truck 100-2 by the side of a periphery from a truck 100, the periphery truck yaw angle 200-2 arises between the direction of center line 23A of slider arm 3A, and the direction of tangent 100-2-T of center line 100-2-C of a truck 100-2.
[0034] By these yaw angle 200-1 or 200-2, the off-track of the magnetic head 2 will occur at the time of record playback so that it may explain below. As shown in the enlarged drawing of (b) of drawing 5 , when the magnetic head 2 is positioned on a truck 100, tangent 100-T of center line 100-C and center line 23of slider arm 3A which is geometric center line of induction type head 2-1 and MR head 2-2 A are substantially parallel. Therefore, exact record playback is possible by detecting the servo pattern signal of the servo track explained to be also the time of playback by Ushiro by MR head 2-2, and making the core of a servo track carry out the on-truck of MR head 2-2 at the time of record. When each magnetic hit alignment of the induction type head 2-1 and MR head 2-2 is not in agreement with a geometric core, the amendment is needed separately. As shown in (a) of drawing 5 R> 5, since the yaw angle 200-1 arises, by truck 100-1 by the side of inner circumference, tangent 100-1-T of center line 100-1-C of a truck 100-1 is not in agreement with center line 23A of the slider arm which is the geometric center line of the induction type head 2-1 and MR head 2-2 from a truck 100. Thus, the amount of gaps of the geometric center to center of MR head 2-2 and the induction type head 2-1 produced according to a yaw angle is defined as "the amount of offset."
[0035] Actuation of record playback of the data to a magnetic disk is performed as shown below. The servo pattern signal of a servo track is detected by MR head 2-2. The time of record of data makes the core of a servo track carry out the on-truck of MR head 2-2, and records data with the induction type head 2-1. At the time of playback of data, it positions in consideration of the amount of offset at the core of data tracks that the induction type head 2-1 wrote in MR head 2-2. As other approaches, MR head 2-2 is positioned in the location which took the amount of offset into consideration, and MR head 2-2 is positioned at the core of data tracks at the time of playback of data so that the induction type head 2-1 may carry out the on-truck of the time of record of data to the core of data tracks. In a periphery side, since the yaw angle 200-2 arises as shown in (c) of drawing 5 , tangent 100-2-T of center line 100-2-C of a truck 100-2 is not in agreement with center line 23A of the slider arm which is the geometric center line of the induction type head 2-1 and MR head 2-2.
[0036] In this case, a servo pattern signal is detected by MR head 2-2. The time of record of data makes the core of a servo track carry out the on-truck of MR head 2-2, and records data with the induction type head 2-1. At the time of playback of data, it positions in consideration of the amount of offset at the core of data tracks that the

induction type head 2-1 wrote in MR head 2-2.
[0037] As other approaches, MR head 2-2 is positioned in the location which took the amount of offset into consideration, and MR head 2-2 is positioned at the core of data tracks at the time of playback of data so that the induction type head 2-1 may carry out the on-truck of the time of record of data to the core of a truck. Thus, in order to make the core of data tracks written in the inner circumference [of a magnetic disk], or periphery side with the induction type head 2-1 carry out the on-truck of MR head 2-2, it is necessary to position MR head 2-2 for the location where only the amount of offset inclined from the core of a servo track. That is, in order to perform head positioning in a high precision, it is necessary to measure the amount of offset in a high precision.
[0038] In the magnetic disk drive of this example 1, the amount of offset is measured in the following procedures. (a) of drawing 6 is the top view of a magnetic disk 1. In drawing, the record section of a magnetic disk 1 is divided into a zone 16 from the concentric circular zone 0 toward an inner circumference side from a periphery side, and each zone consists of two or more trucks, respectively. Each truck has two or more positional information fields (henceforth a servo sector) 300 and data areas 200 which were divided on the periphery. (b) of drawing 6 shows four kinds of servo patterns 300A, 300B, 300C, and 300D written in the servo sector 300 of the truck of a magnetic disk 1. Data are written in the data data area 200. In drawing, magnetic-head 2-A shows a condition in case the magnetic head 2 is positioned on the truck of the center section of the magnetic disk 1, and detects servo pattern 300A for measurement in this case. Magnetic-head 2-B shows a condition in case the magnetic head 2 is positioned on the truck by the side of the periphery of a magnetic disk 1, and detects servo pattern 300B for measurement in this case. The arrow head R in drawing shows the direction of a revolution of a magnetic disk 1.
[0039] Hereafter, the measurement approach of the amount of offset is explained with reference to drawing 1 R> 1, drawing 2 , drawing 5 , and drawing 6 . The figure included in a parenthesis expresses the step of processing.
Step (1): Make the truck of the arbitration near the center of the zone 0 ((a) of drawing 6) by the side of a periphery carry out the on-truck of MR head 2-2 which is the reproducing head, and write pattern 300B for the amount measurement of off-tracks shown at (b) of drawing 6 in all the servo sectors of the truck by the measurement pattern write-in section 6-1 of drawing 1 .
[0040] Step (2): Memorize the position error in each servo sector at the time of the writing of pattern 300B by the position error Management Department 6-3 at the time of pattern writing. If the position error may have exceeded 8% of the track pitch, pattern 300B for the amount measurement of off-tracks will be written in again.
[0041] Step (3): If a position error is less than 8% of a track pitch, four servo sectors which were small as for the position error will be chosen by the servo wedge selection section 6-2-5 as a servo sector for the amount measurement of offset. However, the servo sector chosen due to the measurement processing time is made or less [of the total number of servo sectors of one truck] into 1/8.
Step (4): Make it move to a periphery side half-track pitch P / 2, and position MR head 2-2.
Step (5): Choose the regenerative-signal level of four sectors per revolution, and carry out the memory for 12 data of 12 sectors for three revolutions.
[0042] Step (6): With the measurement wedge average section 6-2-3-1, the measurement count average section 6-2-3-2, and the burst nature disturbance clearance means 6-2-3-4, calculate the average of ten data except what has maximum among 12 data, and the thing which has the minimum value, and memorize the average to an internal memory.
[0043] step (7): -- the magnetic head -- the head jogging section 6-2-2 -- a track pitch -- it moves to an inner circumference side every [64 / 1/], and positions. The location moved, respectively is called measuring point. A step (5) and processing of (6) are repeated 64 times for every measuring point. Drawing 7 shows the regenerative-signal level LV in the same drawing, and expresses both relation as the location of MR head 2-2 which traces a truck (n) after the geometric core has been in agreement with the center line 70. In drawing, the amount of offset shows the gap from the center line 70 of the induction type head 2-1.
[0044] Step (8): The measuring-point average section 6-2-3-3 of drawing 2 averages a total of three regenerative-signal level [seven] of a measuring point a three-piece and inner circumference side the periphery side which adjoins for every measuring point.
[0045] Step (9): The regenerative-signal maximum location detecting element 6-2-4 of drawing 2 detects the point of measurement K of the maximum location which is a location of the reproducing head 2-2 where the regenerative-signal level LV serves as max, as shown in drawing 7 . Drawing 8 is the enlarged drawing of the peak section of the regenerative-signal level LV of drawing 7 , and (a) of drawing 8 , (b), and (c) show three typical examples of the configuration of the peak section, respectively. When the number of the point of measurement K of a maximum location is one, the configuration of the peak section becomes as shown in (b) of drawing 8 , or (c). In this case, by the improvement section 6-2-4-1 in resolution of measurement, the location of maximum is derived from the data of the adjoining location of three pieces. Moreover, in a certain case, the point of measurement K of

a maximum location becomes as shown in (a) of drawing 8 , and, as for the configuration of the peak section, has two or more point of measurement K1 and K2 of two or more maximum locations. The location of maximum is derived based on such point of measurement K1 and K2. Spacing of two or more point of measurement K1 and K2 is equal to the amount of magnetic head offsets. [0046] Step (10): Perform processing from a step (1) to (9) by each zone 0 thru/or 16, and derive the amount of offset for every zone. Step (11): 14 zones 1 and 2 except the zones 16 and 0 of the most inner circumference among the amounts of offset for every zone, and the outermost periphery ... The relation of the track number and the amount of offset in each zone is computed, it outputs to the magnetic head offset storage section 7, and it is made to memorize from the amount of offset of 15. [0047] Step (12): When two or more disks are in a magnetic disk drive, perform this measurement about the magnetic head corresponding to each disk. By the above measurement, the amount of offset of the magnetic head 2 is memorized in the magnetic head offset storage section 7 for every truck. The positioning device 4 is operated by the point-to-point control section 5 by the amendment signal by which the magnetic-head target-position correction section 8 outputs only the distance equivalent to the amount of offset corresponding to the truck of the magnetic head 2 at the time of data playback. It becomes possible to carry out the off-track of MR head 2-2 from a servo track, and to make the core of data tracks carry out an on-truck by this. [0048] As mentioned above, according to the magnetic disk drive of this example 1, it becomes possible by measuring the amount of offset of the magnetic head 2 to high degree of accuracy to make the core of the data tracks of all the zones of a magnetic disk 1 carry out the on-truck of MR head 2-2, and to reproduce data. [0049] <<example 2>> The magnetic disk drive in an example 2 is explained using drawing 9 . Drawing 9 is the block diagram showing the configuration of the magnetic disk drive in the example 2 of this invention. The same sign is given to the same element as an example 1, and the overlapping explanation is omitted. [0050] In the example 2, it has the retry detecting element 9-1 which waits for and redoes that in addition to the configuration of an example 1 a magnetic disk rotates record or playback actuation one time, and the same servo sector comes and which detects the existence of retry actuation, and the offset re-measurement section 9-2 in which re-measurement of the amount of offset of the magnetic head 2 is made to perform according to the occurrence frequency of retry actuation. When the amount of position errors controlled by the point-to-point control section 5 is large and the frequency of generating of retry actuation becomes 5% or more of a count of record playback at the time of record playback, the command signal from the offset re-measurement section 9-2 is made to perform measurement actuation to the time amount which omits record playback again at the magnetic head offset measurement section 6. In this case, when the linear relation by approximation processing between each zone and the amount of offset is, the amount of offset to each zone may be changed based on that relation, without re-measuring for every zone. [0051] The value with the new amount of offset of the magnetic head for which it asked by the above re-measurement is memorized, and only the amount of offset of this memorized magnetic head 2 carries out the off-track of MR head 2-2 from a servo track at the time of data playback. Thereby, it becomes possible to make the core of data tracks carry out the on-truck of MR head 2-2. As mentioned above, when a position error is large, or even when right playback is not completed under the effect of a noise etc., while becoming possible to measure the amount of offset of the magnetic head 2 with high degree of accuracy according to the magnetic disk drive of this example 2, highly precise head positioning is attained. [0052] In addition, in the magnetic disk drive of an example 2, although re-measurement of the amount of offset by the offset re-measurement section 9-2 is performed when the frequency of generating of retry actuation is 5% or more of a count of record playback, the same effectiveness is acquired also in the case of other rates. In addition, at the time of pattern writing although [the magnetic disk drive of an example 1 and an example 2 / the re-writing of the pattern for measurement by the position error Management Department 6-3] it carries out when a position error is 8% or more of a track pitch, it is good also as other rates, such as 5% or more or 10 etc.% or more. Moreover, in the regenerative-signal maximum location detection in the amount measurement section 6-2 of offset, 1 / 2 truck migration of the magnetic head 2 are carried out to a periphery side, and it is measuring to the range for one truck to the inner circumference side (to the location of inner circumference side 1 / 2 truck). However, you may measure toward a periphery side from an inner circumference side. Moreover, the location in early stages of the magnetic head 2 may not be a location which carried out the off-track only of the 1/2 truck. Moreover, measuring range may not be a part for one truck. [0053] Furthermore, although the MR head is used as the reproducing head, the same effectiveness is acquired also by the magnetic head of the compound die which combined other reproducing heads, such as a GMR head. Moreover, four servo wedges per revolution of a magnetic disk are chosen as an object for measurement, and although the servo sector to choose is made or more [of all the servo sectors of one truck] into 1/8, the same effectiveness is acquired even if it chooses the different number. [0054] Moreover, in measurement of the offset measurement section 6-2, although 12 data for three revolutions are acquired, even if the total number of data is 12 or less pieces or the above, the same effectiveness is acquired with the different number of revolutions. Moreover, in a large value, although the burst

nature disturbance clearance section 6-2-3-4 has removed maximum and the minimum value, even if it removes two or more small values, two or more same effectiveness is acquired. [0055] Moreover, it is [every / of track pitch / 64 / 1/] about very small migration of the magnetic head at the time of measurement of the offset measurement section 6-2. Although it is made to move, the same effectiveness is acquired even if it makes it move in pitches other than this. Moreover, in order to perform maximum location detection in the offset measurement section 6-2, it asked for the average of the regenerative signal of three or more adjoining locations, but the same effectiveness is acquired even if it uses statistics processing of spline interpolation etc. [0056] [Effect of the Invention] When making recording density high by narrow track-ization of a magnetic disk according to this invention so that clearly from the place explained to the detail in each above example, based on the amount of offset of the magnetic head measured in a high precision, the magnetic head can be positioned to accuracy. Consequently, the retry actuation by the data error increases at the time of playback, and a continuation data transfer rate does not fall at it.

TECHNICAL FIELD

[Field of the Invention] Especially this invention relates to the magnetic disk drive which prepared a recording head and the reproducing head on the same magnetic-head slider about a magnetic disk drive.

PRIOR ART

[Description of the Prior Art]
[0002] In recent years, the magnetic disk drive of the high density which carries out record playback of mass image information, speech information, the text, etc. at high speed is needed with progress of multimedia.
[0003] The magnetic head which used the MR head or GMR head adapting a magneto-resistive effect for the reproducing head in connection with the densification, and used the induction type head for the recording head is used for the magnetic disk drive. It is equipped with two kinds of above-mentioned heads on the same magnetic-head slider, and they constitute the magnetic head of a compound die.
[0004] As a head positioning device of a magnetic disk drive, there is a demand of a miniaturization and improvement in the speed, and the actuator of the rotary mold which can make effect of inertia small is used with the present magnetic disk drive.
[0005] In the magnetic disk drive which has the actuator of a rotary mold, the locus of the magnetic head when accessing the magnetic head on the truck of a magnetic disk becomes radii. Therefore, it crosses at an include angle which the center line of a magnetic-head slider and the tangent of a recording track are not parallel, but is different for every truck in a periphery, respectively from the inner circumference of a magnetic disk. This include angle is called yaw angle. When the servo track of a magnetic disk is made to carry out the on-truck (for a head to be positioned in the right location on a truck) of the reproducing head according to this yaw angle, in a recording head, an off-track (a head should not be positioned in the right location on a truck) arises. the location gap with the core of a recording head, and the core of the reproducing head -- the gap between each magnetic hit alignment location of a recording head and the reproducing head is strictly called a "head offset."
[0006] With a common magnetic disk drive, at the time of record, after detecting the servo signal currently recorded on the servo track by the MR head which is the reproducing head, moving the magnetic head to a target position and making a servo track carry out the on-truck of the MR head, data are written in a magnetic disk with the induction type head which is a recording head. An MR head will be located at the core of the data signal truck on the magnetic disk written in with the induction type head (data tracks), when making a servo track carry out the on-truck of the MR head and reproducing a data signal by the MR head, if there is a head offset. For this reason, a data signal is unreproducible to accuracy. By the case, the retry actuation which is the repeat of playback actuation is needed, and it has an adverse effect on a continuation data transfer rate.
[0007] Moreover, when a yaw angle is large, and the core of a servo track tends to be made to carry out the on-truck of the MR head and it is going to make the core of the data tracks which recorded with the induction type head and were recorded at the time of playback carry out the on-truck of the MR head, there is a possibility that a head offset may incorrect-detect a track number and a sector number.
[0008] Furthermore, if a yaw angle becomes large, a head offset will also become large, the effective width of recording track at the time of playback will decrease, and the level of a regenerative signal will fall. Moreover, the yaw angle over the hand-of-cut tangent of the magnetic disk of the direction of a magnetic-head projection side

occurs. For this reason, the relative velocity to the slider of the air laminar flow near [which is produced in the tangential direction of that truck by revolution of a smooth magnetic disk] a front face decreases. The lift of the magnetic-head slider which has surfaced decreases by this, and the height of floatation falls.
[0009] In order to avoid many above-mentioned problems, a yaw angle is made desirable [holding down from a maximum of 15 degrees to about 20 degrees], and it is designed so that it may become almost equal on inner circumference and a periphery.
[0010] Thus, in the magnetic head of a compound die, each machine hit alignment and the magnetic hit alignment of the reproducing head of an MR head and the recording head of an induction type head differ from each other. Therefore, especially in the magnetic disk drive of a narrow track pitch, it becomes impossible to disregard the head offset expressed with the distance between each magnetic hit alignment of an MR head and an induction type head, and becomes the big factor of degradation.
[0011] in the magnetic disk drive using this conventional seed magnetic head, the cure as shown in the example since each ** of the following to this head offset is taken.
[0012] It explains as 1st conventional example, referring to drawing 10 about the location gap compensation approach and magnetic disk drive of JP,3-160675,A.
[0013] In drawing 10 , the external datum reference sensor 34 gives positional information to the actuator servo control circuit 35 which controls the revolution actuator 33, and controls the location of the magnetic head 30. The write-in circuit 37 supplies a signal to a recording head 32, and writes the servo information on the 1st set in a magnetic disk 29. Next, the reading head electronic circuitry 38 processes the servo information signal of the 1st set read by the reproducing head 31, gives positional information to the actuator servo control circuit 35, and controls the location of the magnetic head 30. In the location controlled by this servo information signal of the 1st set, the write-in circuit 37 supplies a signal to a recording head 32, and writes the servo information on the 2nd set in a magnetic disk 29.
[0014] Thus, by writing 2 sets of servo information in a magnetic disk 29, the core of data tracks and the core of a servo track are not made in agreement, but only predetermined distance can be shifted. When a recording head 32 is positioned at the core of data tracks in this condition, the reproducing head 31 will be positioned at the core of a servo track. That is, in writing in data, the reproducing head 31 is positioned in the write-in location of the servo information on the 1st set, and it writes in data on the data tracks on the servo code track of the 2nd set by the recording head 32. Thus, 2 sets of written-in servo information is each truck, and it is separated from it of a distance equal to the location gap between the reproducing head and a recording head to radial [of a magnetic disk].
[0015] Next, it explains, referring to drawing 11 about the magnetic disk drive of JP,7-326032,A as 2nd conventional example.
[0016] In drawing 11 , the read head 67 which reproduces the data recorded on the magnetic disk 64, and the write head 68 which records data on a magnetic disk 64 shall separate spacing L2, and carriage 69 shall be equipped with it. Positioning actuation of the head of carriage 69 is controlled by the point-to-point control circuit 17. In the truck 65 of the most inner circumference of a magnetic disk 64, and the truck 66 of the outermost periphery, when the write head 68 is located at the core of trucks 65 and 66, respectively, the amount of gaps of the core of a read head 67 and each core of a truck 65 and a truck 66 is set to YI and YO. Moreover, the include angle which carriage 69 and each tangent of a truck 65 and a truck 66 make is set to thetaI and thetaO. The amount measuring circuit 14 of off-tracks measures the above-mentioned amounts YI and YO of gaps and include-angle thetaI, and thetaO from the output of the read head received from the point-to-point control circuit 17, and computes spacing L2. Based on this spacing L2, the amount Y of amendments for positioning of a head is computed for every truck by the amount calculation circuit 16 of amendments.
[0017] In the above-mentioned configuration, based on the command from the amount measuring circuit 14 of off-tracks, the point-to-point control circuit 17 is controlled so that the write head 68 forms an offset servo pattern on a specific truck. An offset servo pattern is servo data for positioning with which the write head 68 shifted 1/2 track pitch at a time, and was written in the periphery and inner circumference side from the usually written-in truck, respectively. Therefore, the core of the two above-mentioned offset servo patterns is a core of the write head 68, respectively. Since the written-in data location is treated as a servo track, the core between two offset servo patterns is also a core of data tracks. A read head 67 can measure the amounts YI and YO of gaps and include-angle thetaI, and thetaO by positioning based on this offset servo pattern. The spacing L2 of a read head 67 and the write head 68 is computed by the formula (1) by the measured amounts YI and YO of gaps and include-angle thetaI, and thetaO.
[0018]
L2=(YO-YI) / (tanthetaO-tanthetaI) (1)

[0019] The amount Y of head offsets is computable by the formula (2).
[0020]
Y=L2andtantheta (2)
[0021] Here, tantheta as a function of the location of carriage 69 can be approximated. Therefore, it is not necessary to memorize the value of tantheta and the actual amount of amendments is computed using the value computed by the approximation. Memorizing this amount of amendments and correction formula, the amount calculation circuit 16 of amendments computes this amount Y of amendments, outputs it to the point-to-point-control circuit 17, controls positioning actuation of carriage 69, and is positioning the magnetic head.

EFFECT OF THE INVENTION

[Effect of the Invention] When making recording density high by narrow track-ization of a magnetic disk according to this invention so that clearly from the place explained to the detail in each above example, based on the amount of offset of the magnetic head measured in a high precision, the magnetic head can be positioned to accuracy. Consequently, the retry actuation by the data error increases at the time of playback, and a continuation data transfer rate does not fall at it.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] In the 1st conventional example, the amount of amendments is not computed for every truck. Moreover, although the amount of gaps of the machine hit alignment peculiar to the reproducing head and the magnetic hit alignment using a magnetic resistance element changes for each reproducing head of every with dispersion at the time of manufacture of the reproducing head, it has not taken the configuration which can respond to this point. Therefore, in the magnetic disk drive of a narrow track pitch (high track density), the performance degradation of magnetic disk drives, such as an increment in retry actuation and lowering of a continuation data transfer rate, is unavoidable. Moreover, in positioning by the offset servo pattern, in the 2nd conventional example, reference is not made about the point which the error by a noise etc. produces in dispersion in the location in the case of writing in an offset servo pattern, and the measurement result of the amount of head offsets. Moreover, if an error is included by either in order to measure the spacing L2 which is the amount of head offsets only about two trucks, the most inner circumference of a magnetic disk, and the outermost periphery, gross errors will arise in the measured amount of head offsets. For this reason, in the magnetic disk drive of high track density, retry actuation occurs at the time of playback, and it becomes the cause of lowering of a continuation data transfer rate. In order to reduce the count of generating of retry actuation and to make a continuation data transfer rate quick, it has the technical problem that it is highly precise and it necessary to measure the amount of offset.
[0023] In order to abolish the variation in the location at the time of the pattern writing for measurement, there is also a method of performing offset measurement using some servo patterns. However, it has the problem that a servo is not applied at the time of measurement. This invention reduces the count of generating of retry actuation of the magnetic head of a compound die, and aims at offering the magnetic disk drive as for which a continuation data transfer rate is made to a high speed.

MEANS

[Means for Solving the Problem] The magnetic disk drive of this invention is equipped with the magnetic head of the compound die which has the reproducing head which reproduces the recording head which records data on a magnetic disk, and the recorded data. The magnetic head of said compound die is held at a magnetic-head slider, and is positioned by the positioning device section to a target truck. The point-to-point-control section is written in on said magnetic disk, and controls positioning actuation of said positioning device section by the position error

signal showing the inequality of the location of a target truck and said magnetic head based on the servo information reproduced by said magnetic head.
[0025] Furthermore, a magnetic head offset measurement means measures the amount of head offsets of the difference of the location of the reproducing head and the location of a recording head which are produced according to the physical relationship of the reproducing head and the recording head on said magnetic head and which can set said magnetic disk radially. Said measured amount of head offsets is recorded on the magnetic head offset storage means. The positioning target position of the delivery magnetic head is corrected to the point-to-point control section for the amendment signal generated by the magnetic-head target-position correction means based on the amount of head offsets which read it from said magnetic head offset storage means when making the reproducing head follow the information data recorded on the target truck at the time of playback.
[0026] It becomes possible to measure the amount of magnetic head offsets in each truck of the recording head and the reproducing head of the compound-die magnetic head to high degree of accuracy by this configuration, and it becomes possible to make the core of the data tracks written in at the time of playback carry out the on-truck of the MR head which is the reproducing head to accuracy. Thereby, it is realizable the magnetic disk drive [it is possible to decrease generating of the retry actuation by the data playback error at the time of playback, and] which can prevent lowering of a continuation data transfer rate.
[0027] Moreover, said magnetic head offset measurement means has a position error management tool at the time of the pattern writing in which it makes write again with the magnitude of an amount measurement means of offset measure the location whose regenerative-signal output is max, and calculate the amount of offset, and the position error at the time of said signal writing for measurement, carrying out the minute migration of the magnetic head by the measurement pattern write-in means and the head positioning device section which write in the servo pattern of the signal for offset measurement by the recording head on a magnetic disk, and the head point-to-point-control section. A head jogging means by which said amount measurement means of offset carries out very small distance migration of a regenerative-signal output measurement means and the magnetic head, A regenerative-signal equalization means to take the average of the level of the regenerative signal measured for every location of the magnetic head which moved with said head jogging means and was positioned, It has a servo wedge selection means to choose the servo wedge of the magnetic disk which measures said regenerative-signal level according to a playback output maximum location detection means to detect the location of the magnetic head where the greatest regenerative signal is acquired, and the position error at the time of writing. Said regenerative-signal equalization means has the burst nature disturbance clearance means except maximum and the minimum value in count of a measured-value average means to ask for the average of a measurement wedge average means to take the average of the level of the regenerative signal of two or more servo wedges, and at least 3 times or more of measured value, a measuring-point average means to take the average of the measured value of two or more locations, and a measured-value average means.
[0028] With the magnetic head offset measurement means of this configuration, amplification of the error by burst nature disturbance can be prevented. Furthermore, while carrying out very small distance migration with a head jogging means, two or more measured value which measured and measured regenerative-signal level in two or more servo wedges is equalized, and it becomes possible to measure the amount of magnetic head offsets in each truck to high degree of accuracy. Thereby, it is realizable the magnetic disk drive [it is possible to decrease generating of the retry actuation by the data playback error at the time of playback, and] which can prevent lowering of a continuation data transfer rate.
[0029]
[Embodiment of the Invention] It explains referring to drawing 9 from drawing 1 about the suitable example of the magnetic disk drive of this invention below.
<<example 1>> The magnetic disk drive of the example 1 of this invention is explained using drawing 8 from drawing 1 . Drawing 1 is the block diagram showing the configuration of the magnetic disk drive in the example 1 of this invention. In drawing 1 , the compound-die magnetic head 2 is supported by the magnetic-head slider 3 on the field of a magnetic disk 1. The magnetic-head slider 3 is attached in the positioning device section 4 through arm 3A. Positioning actuation of the positioning device section 4 is controlled by the point-to-point control section 5. The magnetic head offset measurement section 6 is equipped with the position error Management Department 6-3 at the time of the measurement pattern write-in section 6-1, the amount measurement section 6-2 of offset, and pattern writing. The output of the magnetic head 2 is inputted into the position error Management Department 6-3 at the time of the pattern writing of the magnetic head offset measurement section 6. The output of the measurement pattern write-in section 6-1 is inputted into the magnetic head 2. The outgoing end of the magnetic head offset measurement section 6 is connected to the input edge of the magnetic head offset storage section 7, and the outgoing end of the magnetic head offset Records Department 7 is connected to the input edge of the

magnetic-head target-position correction section 8. The outgoing end of the magnetic-head target-position correction section 8 is connected to the input edge of the point-to-point control section 5.
[0030] Drawing 2 is the block diagram showing the internal configuration of the amount measurement section 6-2 of offset of drawing 1 . The outgoing end of the servo wedge selection section 6-2-5 prepared in the input edge of the amount measurement section 6-2 of offset is connected to the input edge of the regenerative-signal level test section 6-2-1. The outgoing end of the regenerative-signal level test section 6-2-1 is connected to the input edge of the regenerative-signal equalization section 6-2-3. The outgoing end of the regenerative-signal equalization section 6-2-3 is connected to the input edge of the regenerative-signal maximum location detecting element 6-2-4. The outgoing end of the regenerative-signal maximum location detecting element 6-2-4 is connected to the input edge of the magnetic head offset Records Department 7. The outgoing end of the head jogging section 6-2-2 is connected to other input edges of the regenerative-signal level test section 6-2-1.
[0031] In the regenerative-signal equalization section 6-2-3, the outgoing end of the measurement wedge average section 6-2-3-1 prepared in the input edge of the regenerative-signal equalization section 6-2-3 is connected to the input edge of the measured-value average section 6-2-3-2. The outgoing end of the measured-value average section 6-2-3-2 is connected to the input edge of the burst nature disturbance clearance section 6-2-3-4. The outgoing end of the burst nature disturbance clearance section 6-2-3-4 is connected to the input edge of the measuring-point average section 6-2-3-3, and the input edge of the head jogging section 6-2-2, and the outgoing end of the measuring-point average section 6-2-3-3 is connected to the input edge of the regenerative-signal maximum location detecting element 6-2-4. The regenerative-signal maximum location detecting element 6-2-4 has the improvement section 6-2-4-1 in resolution of measurement.
[0032] the top view of the field where drawing 3 counters the magnetic disk 1 of the magnetic head 2 -- it is -- the magnetic disk drive of this example 1 -- it is and the magnetic head 2 of the compound die which performs record playback is formed in the edge of the magnetic-head slider 3. In the magnetic head 2, through the magnetic-shielding plate 2-3-2, only predetermined distance separates and the induction type head 2-1 of the thin film which is a recording head, and the magneto-resistive effect mold head (henceforth an MR head) 2-2 which is the reproducing head are formed. Between the magnetic head 2 and the magnetic-head slider 3, the magnetic-shielding plate 2-3-1 is formed. MR head 2-2, the induction type head 2-1, the shielding plate 2-3-1, and 2-3-2 are held through the protective layer of an alumina 2-4 at the magnetic-head slider 3, respectively. It attaches in the positioning device section 4 through arm 3A, and the magnetic-head slider 3 is ************.
[0033] Drawing 4 and drawing 5 are the top views of the magnetic disk drive for explaining the yaw angle in the oscillating motor which is the positioning device section 4. In drawing 4 , arm 3A holding the magnetic-head slider 3 rotates around the pivot 4-1 by the positioning device section 4 which has voice coil motor 4A. When there is a magnetic-head slider 3 in the center in the data area A of a magnetic disk 1, the physical relationship of a magnetic disk 1 and the positioning device section 4 is set up so that a yaw angle may become zero. The truck 100 in drawing is a truck of yaw angle zero. As shown in the enlarged drawing of (a) of drawing 5 , when the magnetic head 2 is positioned from a truck 100 on the truck 100-1 by the side of inner circumference, the inner circumference truck yaw angle 200-1 arises between the direction of center line 23A of arm 3A, and the direction of tangent 100-1-T of center line 100-1-C of a truck 100-1. Moreover, as shown in the enlarged drawing of (c) of drawing 5 , when the magnetic head 2 is positioned on the truck 100-2 by the side of a periphery from a truck 100, the periphery truck yaw angle 200-2 arises between the direction of center line 23A of slider arm 3A, and the direction of tangent 100-2-T of center line 100-2-C of a truck 100-2.
[0034] By these yaw angle 200-1 or 200-2, the off-track of the magnetic head 2 will occur at the time of record playback so that it may explain below. As shown in the enlarged drawing of (b) of drawing 5 , when the magnetic head 2 is positioned on a truck 100, tangent 100-T of center line 100-C and center line 23of slider arm 3A which is geometric center line of induction type head 2-1 and MR head 2-2 A are substantially parallel. Therefore, exact record playback is possible by detecting the servo pattern signal of the servo track explained to be also the time of playback by Ushiro by MR head 2-2, and making the core of a servo track carry out the on-truck of MR head 2-2 at the time of record. When each magnetic hit alignment of the induction type head 2-1 and MR head 2-2 is not in agreement with a geometric core, the amendment is needed separately. As shown in (a) of drawing 5 R> 5, since the yaw angle 200-1 arises, by truck 100-1 by the side of inner circumference, tangent 100-1-T of center line 100-1-C of a truck 100-1 is not in agreement with center line 23A of the slider arm which is the geometric center line of the induction type head 2-1 and MR head 2-2 from a truck 100. Thus, the amount of gaps of the geometric center to center of MR head 2-2 and the induction type head 2-1 produced according to a yaw angle is defined as "the amount of offset."
[0035] Actuation of record playback of the data to a magnetic disk is performed as shown below. The servo pattern signal of a servo track is detected by MR head 2-2. The time of record of data makes the core of a servo

track carry out the on-truck of MR head 2-2, and records data with the induction type head 2-1. At the time of playback of data, it positions in consideration of the amount of offset at the core of data tracks that the induction type head 2-1 wrote in MR head 2-2. As other approaches, MR head 2-2 is positioned in the location which took the amount of offset into consideration, and MR head 2-2 is positioned at the core of data tracks at the time of playback of data so that the induction type head 2-1 may carry out the on-truck of the time of record of data to the core of data tracks. In a periphery side, since the yaw angle 200-2 arises as shown in (c) of drawing 5 , tangent 100-2-T of center line 100-2-C of a truck 100-2 is not in agreement with center line 23A of the slider arm which is the geometric center line of the induction type head 2-1 and MR head 2-2.
[0036] In this case, a servo pattern signal is detected by MR head 2-2. The time of record of data makes the core of a servo track carry out the on-truck of MR head 2-2, and records data with the induction type head 2-1. At the time of playback of data, it positions in consideration of the amount of offset at the core of data tracks that the induction type head 2-1 wrote in MR head 2-2.
[0037] As other approaches, MR head 2-2 is positioned in the location which took the amount of offset into consideration, and MR head 2-2 is positioned at the core of data tracks at the time of playback of data so that the induction type head 2-1 may carry out the on-truck of the time of record of data to the core of a truck. Thus, in order to make the core of data tracks written in the inner circumference [of a magnetic disk], or periphery side with the induction type head 2-1 carry out the on-truck of MR head 2-2, it is necessary to position MR head 2-2 for the location where only the amount of offset inclined from the core of a servo track. That is, in order to perform head positioning in a high precision, it is necessary to measure the amount of offset in a high precision.
[0038] In the magnetic disk drive of this example 1, the amount of offset is measured in the following procedures. (a) of drawing 6 is the top view of a magnetic disk 1. In drawing, the record section of a magnetic disk 1 is divided into a zone 16 from the concentric circular zone 0 toward an inner circumference side from a periphery side, and each zone consists of two or more trucks, respectively. Each truck has two or more positional information fields (henceforth a servo sector) 300 and data areas 200 which were divided on the periphery. (b) of drawing 6 shows four kinds of servo patterns 300A, 300B, 300C, and 300D written in the servo sector 300 of the truck of a magnetic disk 1. Data are written in the data data area 200. In drawing, magnetic-head 2-A shows a condition in case the magnetic head 2 is positioned on the truck of the center section of the magnetic disk 1, and detects servo pattern 300A for measurement in this case. Magnetic-head 2-B shows a condition in case the magnetic head 2 is positioned on the truck by the side of the periphery of a magnetic disk 1, and detects servo pattern 300B for measurement in this case. The arrow head R in drawing shows the direction of a revolution of a magnetic disk 1.
[0039] Hereafter, the measurement approach of the amount of offset is explained with reference to drawing 1 R> 1, drawing 2 , drawing 5 , and drawing 6 . The figure included in a parenthesis expresses the step of processing.
Step (1): Make the truck of the arbitration near the center of the zone 0 ((a) of drawing 6) by the side of a periphery carry out the on-truck of MR head 2-2 which is the reproducing head, and write pattern 300B for the amount measurement of off-tracks shown at (b) of drawing 6 in all the servo sectors of the truck by the measurement pattern write-in section 6-1 of drawing 1 .
[0040] Step (2): Memorize the position error in each servo sector at the time of the writing of pattern 300B by the position error Management Department 6-3 at the time of pattern writing. If the position error may have exceeded 8% of the track pitch, pattern 300B for the amount measurement of off-tracks will be written in again.
[0041] Step (3): If a position error is less than 8% of a track pitch, four servo sectors which were small as for the position error will be chosen by the servo wedge selection section 6-2-5 as a servo sector for the amount measurement of offset. However, the servo sector chosen due to the measurement processing time is made or less [of the total number of servo sectors of one truck] into 1/8.
Step (4): Make it move to a periphery side half-track pitch P / 2, and position MR head 2-2.
Step (5): Choose the regenerative-signal level of four sectors per revolution, and carry out the memory for 12 data of 12 sectors for three revolutions.
[0042] Step (6): With the measurement wedge average section 6-2-3-1, the measurement count average section 6-2-3-2, and the burst nature disturbance clearance means 6-2-3-4, calculate the average of ten data except what has maximum among 12 data, and the thing which has the minimum value, and memorize the average to an internal memory.
[0043] step (7): -- the magnetic head -- the head jogging section 6-2-2 -- a track pitch -- it moves to an inner circumference side every [64 / 1/], and positions. The location moved, respectively is called measuring point. A step (5) and processing of (6) are repeated 64 times for every measuring point. Drawing 7 shows the regenerative-signal level LV in the same drawing, and expresses both relation as the location of MR head 2-2 which traces a truck (n) after the geometric core has been in agreement with the center line 70. In drawing, the amount of offset shows the gap from the center line 70 of the induction type head 2-1.

[0044] Step (8): The measuring-point average section 6-2-3-3 of drawing 2 averages a total of three regenerative-signal level [seven] of a measuring point a three-piece and inner circumference side the periphery side which adjoins for every measuring point.
[0045] Step (9): The regenerative-signal maximum location detecting element 6-2-4 of drawing 2 detects the point of measurement K of the maximum location which is a location of the reproducing head 2-2 where the regenerative-signal level LV serves as max, as shown in drawing 7 . Drawing 8 is the enlarged drawing of the peak section of the regenerative-signal level LV of drawing 7 , and (a) of drawing 8 , (b), and (c) show three typical examples of the configuration of the peak section, respectively. When the number of the point of measurement K of a maximum location is one, the configuration of the peak section becomes as shown in (b) of drawing 8 , or (c). In this case, by the improvement section 6-2-4-1 in resolution of measurement, the location of maximum is derived from the data of the adjoining location of three pieces. Moreover, in a certain case, the point of measurement K of a maximum location becomes as shown in (a) of drawing 8 , and, as for the configuration of the peak section, has two or more point of measurement K1 and K2 of two or more maximum locations. The location of maximum is derived based on such point of measurement K1 and K2. Spacing of two or more point of measurement K1 and K2 is equal to the amount of magnetic head offsets. [0046] Step (10): Perform processing from a step (1) to (9) by each zone 0 thru/or 16, and derive the amount of offset for every zone. Step (11): 14 zones 1 and 2 except the zones 16 and 0 of the most inner circumference among the amounts of offset for every zone, and the outermost periphery ... The relation of the track number and the amount of offset in each zone is computed, it outputs to the magnetic head offset storage section 7, and it is made to memorize from the amount of offset of 15. [0047] Step (12): When two or more disks are in a magnetic disk drive, perform this measurement about the magnetic head corresponding to each disk. By the above measurement, the amount of offset of the magnetic head 2 is memorized in the magnetic head offset storage section 7 for every truck. The positioning device 4 is operated by the point-to-point control section 5 by the amendment signal by which the magnetic-head target-position correction section 8 outputs only the distance equivalent to the amount of offset corresponding to the truck of the magnetic head 2 at the time of data playback. It becomes possible to carry out the off-track of MR head 2-2 from a servo track, and to make the core of data tracks carry out an on-truck by this. [0048] As mentioned above, according to the magnetic disk drive of this example 1, it becomes possible by measuring the amount of offset of the magnetic head 2 to high degree of accuracy to make the core of the data tracks of all the zones of a magnetic disk 1 carry out the on-truck of MR head 2-2, and to reproduce data. [0049] <<example 2>> The magnetic disk drive in an example 2 is explained using drawing 9 . Drawing 9 is the block diagram showing the configuration of the magnetic disk drive in the example 2 of this invention. The same sign is given to the same element as an example 1, and the overlapping explanation is omitted. [0050] In the example 2, it has the retry detecting element 9-1 which waits for and redoes that in addition to the configuration of an example 1 a magnetic disk rotates record or playback actuation one time, and the same servo sector comes and which detects the existence of retry actuation, and the offset re-measurement section 9-2 in which re-measurement of the amount of offset of the magnetic head 2 is made to perform according to the occurrence frequency of retry actuation. When the amount of position errors controlled by the point-to-point control section 5 is large and the frequency of generating of retry actuation becomes 5% or more of a count of record playback at the time of record playback, the command signal from the offset re-measurement section 9-2 is made to perform measurement actuation to the time amount which omits record playback again at the magnetic head offset measurement section 6. In this case, when the linear relation by approximation processing between each zone and the amount of offset is, the amount of offset to each zone may be changed based on that relation, without re-measuring for every zone. [0051] The value with the new amount of offset of the magnetic head for which it asked by the above re-measurement is memorized, and only the amount of offset of this memorized magnetic head 2 carries out the off-track of MR head 2-2 from a servo track at the time of data playback. Thereby, it becomes possible to make the core of data tracks carry out the on-truck of MR head 2-2. As mentioned above, when a position error is large, or even when right playback is not completed under the effect of a noise etc., while becoming possible to measure the amount of offset of the magnetic head 2 with high degree of accuracy according to the magnetic disk drive of this example 2, highly precise head positioning is attained. [0052] In addition, in the magnetic disk drive of an example 2, although re-measurement of the amount of offset by the offset re-measurement section 9-2 is performed when the frequency of generating of retry actuation is 5% or more of a count of record playback, the same effectiveness is acquired also in the case of other rates. In addition, at the time of pattern writing although [the magnetic disk drive of an example 1 and an example 2 / the re-writing of the pattern for measurement by the position error Management Department 6-3] it carries out when a position error is 8% or more of a track pitch, it is good also as other rates, such as 5% or more or 10 etc.% or more. Moreover, in the regenerative-signal maximum location detection in the amount measurement section 6-2 of offset, 1 / 2 truck migration of the magnetic head 2 are carried out to a periphery side, and it is measuring to the

range for one truck to the inner circumference side (to the location of inner circumference side 1 / 2 truck). However, you may measure toward a periphery side from an inner circumference side. Moreover, the location in early stages of the magnetic head 2 may not be a location which carried out the off-track only of the 1/2 truck. Moreover, measuring range may not be a part for one truck. [0053] Furthermore, although the MR head is used as the reproducing head, the same effectiveness is acquired also by the magnetic head of the compound die which combined other reproducing heads, such as a GMR head. Moreover, four servo wedges per revolution of a magnetic disk are chosen as an object for measurement, and although the servo sector to choose is made or more [of all the servo sectors of one truck] into 1/8, the same effectiveness is acquired even if it chooses the different number. [0054] Moreover, in measurement of the offset measurement section 6-2, although 12 data for three revolutions are acquired, even if the total number of data is 12 or less pieces or the above, the same effectiveness is acquired with the different number of revolutions. Moreover, in a large value, although the burst nature disturbance clearance section 6-2-3-4 has removed maximum and the minimum value, even if it removes two or more small values, two or more same effectiveness is acquired. [0055] Moreover, it is [every / of track pitch / 64 / 1/] about very small migration of the magnetic head at the time of measurement of the offset measurement section 6-2. Although it is made to move, the same effectiveness is acquired even if it makes it move in pitches other than this. Moreover, in order to perform maximum location detection in the offset measurement section 6-2, it asked for the average of the regenerative signal of three or more adjoining locations, but the same effectiveness is acquired even if it uses statistics processing of spline interpolation etc. [0056]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The block diagram of the magnetic disk drive in the example 1 of this invention.
[Drawing 2] The block diagram of the amount measurement section of offset in the example 1 of this invention.
[Drawing 3] The top view of the magnetic head in an example 1.
[Drawing 4] The top view for the explanation about the yaw angle of the magnetic disk drive in the example 1 of this invention.
[Drawing 5] The amplification top view for the explanation about the yaw angle of the magnetic disk drive in the example 1 of this invention.
[Drawing 6] For (a), the top view showing the record section of the magnetic disk in the example 1 of this invention and (b) are the servo pattern of the magnetic disk of (a).
[Drawing 7] The top view of the magnetic disk for explanation of offset measurement of the magnetic disk drive in the example 1 of this invention.
[Drawing 8] (a) It is the graph of the output level for maximum location detection of a magnetic disk drive [in / there is nothing and / in (c) / the example 1 of this invention].
[Drawing 9] The block diagram of the magnetic disk drive in the example 2 of this invention.
[Drawing 10] The block diagram of the magnetic disk drive of the 1st conventional example.
[Drawing 11] The block diagram of the magnetic disk drive of the 2nd conventional example.
[Description of Notations]
1 Magnetic Disk
2 Compound-Die Magnetic Head
3 Magnetic-Head Slider
3A Arm
4 Positioning Device Section
4A Voice coil motor
4-1 Pivot
5 Point-to-point Control Section
6 Magnetic Head Offset Measurement Section
6-1 Measurement Pattern Write-in Section
6-2 The Amount Measurement Section of Offset
6-2-1 Regenerative-Signal Level Test Section
6-2-2 Head Jogging Section
6-2-3 Regenerative-Signal Equalization Section
6-2-3-1 Measurement Wedge Average Section

6-2-3-2 Measured-Value Average Section
6-2-3-3 Measuring-Point Average Section
6-2-3-4 Burst Nature Disturbance Clearance Section
6-2-4 Regenerative-Signal Maximum Location Detecting Element
6-2-4-1 Improvement Section in Resolution of Measurement
6-2-5 Servo Wedge Selection Section
6-3 He is Position Error Management Department at the Time of Pattern Writing.
7 Magnetic Head Offset Storage Section
8 Magnetic-Head Target-Position Correction Section
9-1 Retry Detecting Element
9-2 Offset Re-Measurement Section
23A Geometric center line
100 Truck
100-1 Truck
100-2 Truck
200 Data Area
200-1 Yaw Angle
200-2 Yaw Angle
300 Positional Information Field